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Engineering News-Record

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May 29, 1919

How One Contractor Went About a Housing Job

Building 450 small dwellings for shipyard workers in limited time required organization of forces and planning of operations in different manner than for usual large contract job.

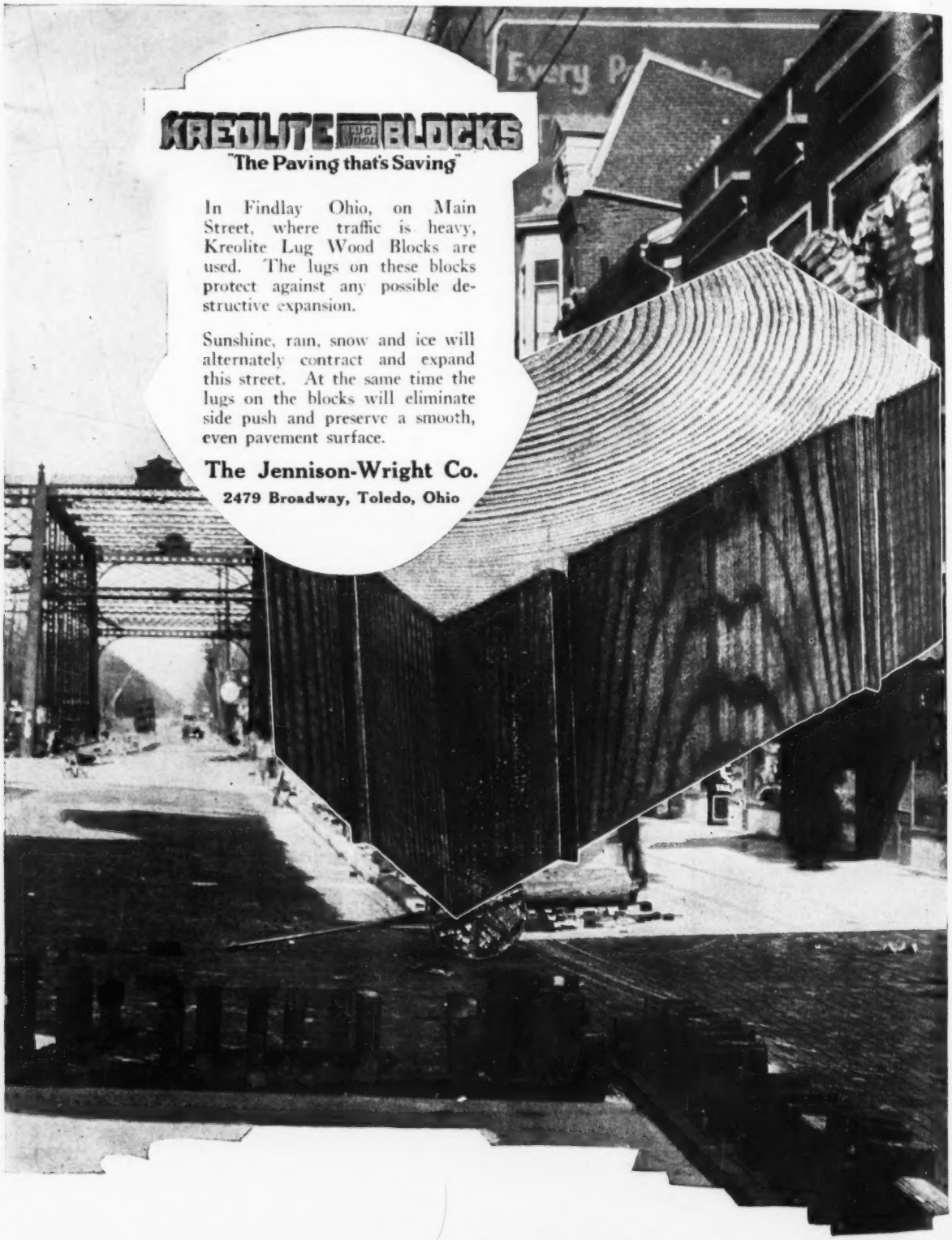
By JOSEPH MELTZER

Design and Construction of Navy Concrete Oil Barges

Boats built at Hudson River yard have oil holds protected by air compartments and also may carry deck loads. Launching ways are concrete platforms carrying timber stringers.

By R. M. BURKHALTER

Louisville Bridge Span of Record Length Being Erected by Gantry Traveler 145 Feet High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ENGINEERING NEWS-RECORD

DEVOTED TO CIVIL ENGINEERING AND CONTRACTING

E. J. MEHREN, Editor — CHARLES WHITING BAKER, Consulting Editor

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Government Tax on Information

ON AND after July 1 it will be necessary to charge subscribers of ***Engineering News-Record*** living west of the Mississippi River an extra $1 per year to cover partially the increased cost of postage.

Zone rates of postage, adopted as a war measure, became effective on magazines July 1, 1918, thus reestablishing a system abolished as obsolete in 1863. The zone rates, however, are to persist after the war, and are to increase in four successive steps, reaching their maximum July 1, 1921. The publishers had hoped that the law would be repealed, and for that reason bore the burden themselves for the first year. On the first of next July, however, when the second increment becomes effective, it will be necessary to add a postage charge for zones farthest from the point of publication.

The postage on a copy of ***Engineering News-Record*** under the old law was about 72c. a year to any point in the country. In the year beginning July 1, 1919, it will be $2.38, $2.90 and $3.16, respectively, in the sixth, seventh and eighth zones, in which the states west of the Mississippi lie. When the zone rates are fully effective these rates will become $3.94, $4.98 and $5.50, respectively, so that further increases in subscription price to cover added postage seem inevitable.

In studying the law, when first passed, it was proposed to add a postage charge in each zone, but the clerical difficulties introduced were so great that it was found necessary to lay a flat increase on the greater distances. The added amount for postage decided on for the sixth zone was adopted also for the seventh and eighth zones, thus covering all the territory west of the Mississippi.

Therefore, with all subscriptions, new and renewals, sent in on and after July 1 from points west of the Mississippi River an extra $1 should be added for zone postage.

The publishers greatly regret the necessity for taking this step. It has been forced upon them by legislation which places information in the same class as merchandise and penalizes the educational efforts of those who live in the most distant parts of the country. Progress in postal matters has always been marked by a change from the zone system to a flat basis; throughout the world the theory is accepted that there should not be a distance tax on education and enlightenment. Under that theory a 5c. stamp carries a letter to Guatemala, to South Africa or to Japan.

We have no doubt that when the restrictive and sectionalizing character of this legislation becomes apparent the people will demand its repeal.

THE PUBLISHERS.

Septic Tank Patent Settlement in Sight

THE proposed settlement of the Cameron septic tank patent litigation, noted on p. 1084, promises to bring to an end a long and stubborn contest in which many engineers and municipalities have coöperated to resist what they believe to have been invalid claims. The sum to be paid, in which any alleged infringer may join and thus be freed from possible litigation, is so small as to seem like a virtual confession of either the weakness of the case or else of exhausted resources on the part of the claimant. Nevertheless, the remarkable league of states, cities, companies and individual engineers who have stood united in the long fight is presumably wise to accept the compromise, on the ground that the expense will be trifling and the freedom from further annoyance worth while. Those interested in joint civic and private action to defend patent claims will be repaid for obtaining the printed information summarizing this settlement agreement.

Exhibit Promoted by Engineers

WHILE we have been talking about the need for fuller realization by engineers of their local civic responsibilities, an example has been set which deserves hearty commendation. We refer to the industrial exhibition recently held in the 23rd Regiment Armory in Brooklyn, N. Y., under the auspices of the Brooklyn Engineers' Club. Beginning with a few loans shown at the club house, the exhibition reached such a size that only the largest armory in Brooklyn could house it. The main object sought by the club was to place the industrial importance of the Borough of Brooklyn before its citizens in a clear light, with a view to creating and maintaining an active public interest and a pride in Brooklyn's manufacturing progress. The club long ago realized that engineers should take a larger part in civic matters and that a great power for good can be secured from the coöperation of responsible engineering bodies, manufacturers and business men in bringing about civic improvements. An engineering society which shows so keen an appreciation of the responsibility of the engineer in the present age of industrialism as did the Brooklyn Engineers' Club in this case should be congratulated and emulated.

Organization in Lumber Camps

WHEN the Spruce Production Division was organized, and sought to secure a greater rate of production in the Northwest woods, the first obstacle was the labor problem. Labor was in a sullen, ugly mood throughout the Northwest camps. Efficiency was way below par, and there were dissatisfaction and grievance on the part of employer and employee. How General Disque brought employer and employee together on the common ground of loyalty is one of the

important chapters of war-time production. It has a significance now in the fact that the Loyal Legion of Loggers and Lumbermen, the organization 110,000 strong which grew out of General Disque's plan, has elected to continue permanently. In other words, the benefits of a common or joint council as the ruling body in the great industry were so patent to all that the workers themselves voted to continue the organization even after the pressure of war-time necessity had been removed. There is excellent example for other industries, and food for thought for both employer and employee, in the operating plan of the Loyal Legion of Loggers and Lumbermen.

Wanted—A Cheap, Acceptable House

ENGINEERS have not had much to do with building dwelling houses. The single house is so obviously the architect's field that when the number is multiplied, and whole villages are built at once, it is the architect who dominates the design and construction of the houses themselves and leaves to the engineer the public utilities alone. Such was the case with the Government housing program carried out during the war. In consequence, we find that practically nothing valuable was developed by this forced work, in the way of novel or economical house design. The engineer is accustomed to multiple production, to the reduction of pieces and effort by the repetition of the unit. The architect, on the other hand, is concerned with the general effect, and concentrates on the perfection of the unit itself. Much was saved in the Government housing by the development of contracting methods such as are outlined by Mr. Meltzer on another page, but the impression cannot be avoided that some cheaper, and equally pleasing, form of multiple housing could have been developed than the succession of suburban villas which look so delightful in the architect's perspective but which lend themselves so little to economies of production. War emergencies have passed, but the housing shortage is worse than ever. Engineers cannot escape their duty of entering this field. Can they not impress their ideas on the design of the house itself, so that there may result that only solution of the present deadlock between high prices and necessity for shelter—reduced unit costs due to efficient design as well as efficient management of construction?

America's Legacy

IN THE concluding sentence of his address before the National Machine Tool Manufacturers' Association, Charles F. Lang, president of the Lakewood Engineering Co., expressed the thought that, whereas Greece had given us art and Rome law and organization, America would give to the ages a solution of the problem of the "proper distribution of wealth and happiness and education among the masses." Certainly, there is warrant for thinking at the present time that America will make real progress in these directions. Back of Mr. Lang's thought, however, is something very much larger than he had room to develop in that sentence. There is something spiritual, and in that lies all the hope for America's thinkers and America's industrial leaders doing their utmost to reach a real solution of the industrial problem. Mere spreading of wealth will not of itself bring a social order of which we would be proud. A better spreading of the world's goods would be but the means to a geater end. The fullest spiritual development of the individual will come when a qualitative standard again becomes the object of human endeavor, replacing the quantitative standard which has debased our industrial age. That thought is inherent in Mr. Lang's expression when he speaks of happiness and education, for happiness does not consist in the enjoyment of purely material things, nor can education be worthy of the name if it be nothing more than a surface polish, leaving below an undeveloped soul and a weak character. The thought expanded, as it lay in Mr. Lang's mind, is indeed an idea worthy of a great people. It will come only through sacrifice by those who control and direct our destinies, and through an awakening of the nation as a whole to a realization of how our industrial structure ramifies through and vitally affects the life of every individual.

Human Side of Labor and the Engineer Must Be Recognized

CONSIDERATION of the laborer in his human and personal relations rather than as merely an impersonal physical machine is becoming increasingly necessary. That this is being recognized by engineers who have to handle labor was shown by opinions voiced at the recent meeting of the American Railway Engineering Association, as noted in *Engineering News-Record* of Apr. 10, 1919, p. 698, the subject coming up in a discussion of plans for camp buildings and boarding cars, as submitted by the committee on economics of railway labor.

Much of the attention to the physical welfare of laborers has been based upon improving the human machine as an asset of the employer, and has been confined largely to housing and feeding. But there is a growing recognition of the fact that the employer or superior must be willing to consider the worker as an individual and to assist his development in his own—the laborer's—personal interest. In doing this he will help to make the men better citizens, besides cultivating a spirit of loyalty and coöperation instead of indifference or perhaps antagonism.

Higher efficiency is the demand of the time, but in the discussion noted it was pointed out by R. H. Ford, Rock Island Lines, that at present there is low efficiency of common labor as employed on railway construction and maintenance. This condition he attributed largely to the poor grade of housing and feeding that the railways have been content to provide, because they have failed to appreciate even the benefits resulting to themselves from better care of their men. In Mr. Ford's opinion, the great improvement made in recent years in this respect is but the beginning of a much broader improvement. Regard for the human element in the problem, for the benefit of the laborer rather than the employer, was emphasized by J. L. Campbell, of the El Paso & Southwestern R. R. He urged that it is necessary to recognize the fact that the laborer—like any other man—has ideas and aspirations of his own, beyond his mere daily needs and his employment.

Perhaps one reason for the shifting habits of common labor is the fact that welfare methods ordinarily do not go beyond the housing and feeding of the men. Under such conditions there may be no particular inducement for them to stay in any one place. The next employer or job or camp may be better, or if it is worse there is another further on. Checking oppor-

tunities for such casual movement may have some effect, but a better solution seems to be in considering the men as individuals and fellow human beings. This does not imply the babying or coddling of the men, but simply a square man-to-man treatment that will benefit not only the laborer but also the employer and the community.

While the discussion mentioned had relation to common labor, particularly on railway work, the same conditions apply to the skilled laborer and the engineer employee. That employers have shown slight regard for the human aspects of the young engineer and technical beginner is probably a large cause of the unrest and dissatisfaction among the men from whom the engineering profession of the future must be recruited. A new attitude toward and a new sense of responsibility for the technical man and the workman, on the part of the employer, promoting a different relation between employer and employee, may be foreseen among the coming changes.

Scrapping Tons of Good Highway Bridge Metal Because of Local Corrosion

SEVERAL recent cases of highway-bridge repair call attention to the abnormal liability to deterioration of steel at the level of the decking and in certain locations under the floor. The life of many bridges is determined by loss of strength at these points, though elsewhere the full initial strength remains. Facts of experience amply justify the statement that the life of a steel highway bridge is unlimited if trouble at points of special corrosion is taken care of—and, of course, provided cleaning and painting are not neglected. For this reason the engineer's aim must be to eliminate local troubles.

In one case serious loss of strength resulted from corrosion of the web members of a through truss at the point where they pass through the wooden decking. Dirt and moisture, accumulating in the slots cut in the decking for the passage of the posts and diagonals, cut into the metal like a chisel. With concrete deck the same thing would have happened, the members passing through the floor by similar openings (or even much larger ones.) There was also abnormal corrosion at certain points under the floor, as where spiking pieces rested on stringer flanges so that moisture could be retained between the contact surfaces, and where floor planking came so close to the top of a floor-beam that dirt could pocket between them. These conditions are in all respects typical. They establish very definitely the fact that past highway-bridge practice has not given sufficiently careful attention to the protection of steel at and under the floor.

Studies for repairing a Chicago viaduct over railway tracks recently brought out the same general truth, in a totally different set of circumstances. Locomotive gases (acting below the deck level) were the corroding agency in this case. They weakened the bottom chord and stringers so that only half their original strength remained, while the rest of the structure was as good as new; emergency repairs were the only means of avoiding immediate replacement of the entire structure. Enough was known of locomotive-blast corrosion, at the time this viaduct was designed, to enable the after-history to be fairly well foreseen. Yet, with a hopefulness out of all experience, the designer, following the precedent set by many other bridge designers, counted on paint protection to resist this corrosive action. On the occasion of the repair work, however, the engineer who analyzed the case could not escape the broadly general conclusion that highway bridges over tracks should have no part of their steel structure located below the floor.

This is a very sweeping recommendation. As such, however, it is welcome evidence of bold and decided thinking in the matter of the local-corrosion problem. No progress has been made in the past under the plan of letting local corrosion take care of itself, but progress may result if we will face the facts and use every available expedient in the effort to prevent the undesired destruction.

Floors suspended below the truss chords, and so designed as to curtain the smoke away from the steel, would require some interesting modifications of typical design details. A concrete floor slab or a suspended ceiling would have to be used, and in the case of timber-floor highway bridges, as in the case first mentioned, the application of the principle might prove difficult. But any solution of the local-corrosion problem is worth discussion. Under past practice many tons of highway bridges have been thrown into the scrap heap because a few pounds of metal were eaten away by local corrosion.

Care in Foundation Work

NEGLECT in the examination of foundation conditions or in the design or construction of a substructure is sure to cause trouble sooner or later. This trite warning needs constant reiteration in view of the recurrence of failures. The settlement and failure of the Minneapolis armory described in this issue is a new instance. Two months ago the settlement brought to light a peculiarly prominent example. An equally remarkable case in another field was the failure of a drawbridge pivot pier because grossly faulty construction and inspection resulted in making the base only half as large as the body of the pier, as described in *Engineering News-Record* of Sept. 13, 1917, p. 484. Shortly before that time, water-works construction contributed a similar example in the Cleveland filter-house difficulties.

Piles of inadequate number and length in a deep bed of soft mud were responsible for the settlement that wrecked the Minneapolis building. Apart from the question of whether the soil conditions had been considered, it is clear that improper construction and inspection were factors in the case. The piles sank a foot or more under the final blow of the hammer, yet a heavy structure was built on them. The settlement that was to be looked for began even during construction, but apparently nothing more was done about it than leveling up the irregular floor with additional concrete.

Experience thus gives ample warrant for the caution that foundation work preëminently demands zeal and care—too much rather than too little. This applies equally to preliminary investigation, to design and to construction and its supervision. Failures have occurred in spite of all care, but that is an added reason for special thoroughness. The responsibility rests on the engineer; in case of a failure, even if he is blameless, the public is likely to place the blame upon him and the engineering profession.

How One Contractor Went About a Housing Job

Building 450 Small Dwellings for Shipyard Workers in Limited Time Required Organization of Forces and Planning of Operations in Different Manner From That of Usual Large-Contract Job

By Joseph Meltzer
Of Joseph Meltzer & Co., Contractors and Engineers, Boston, Mass.

LARGE-size housing operations involve as much material and labor as the ordinary construction job of similar cost, but the wide area over which the work is done, and the multiplicity of small similar units it involves, make them quite different in many ways from the usual contract operation. The problems in one such war-time job, Project 62 of the United States Housing Corporation at Quincy, Mass., for the workers of the Fore River shipyard, were both engrossing and difficult. First and foremost came the problem of grouping operations and sections of the work and arranging them in sequence for all classes of labor; second came the problem of obtaining the material and delivering and storing it in a way which would eliminate double handling and delay in the work; third came the proper coördination of field and office-organization help; fourth, the problem of grouping labor units under foremen and subforemen so that shirking and idling would be cut down to a minimum.

HOUSES OF SAME INTERIOR LAYOUT WERE VARIED IN EXTERNAL APPEARANCE

The project consisted of 256 houses, one-third of which were single six-room houses, and two-thirds double houses with four rooms in each part. Most of them were of common frame construction, with brick first floor, and a few were entirely of brick. The foundations were built entirely of concrete, using the run of the bank for the concrete aggregate, with no waterproofing or exterior finish except for surfacing with a thin grout above the grade line. The frames of the houses were of the ordinary type, with a 2 x 4-in. studding, 4 x 6-in. corner posts, clapboard or shingled as was required by the architect, with double floors throughout, and with mineral-coated asphalt shingles for most of the roofs and slate for others.

The entire project was divided into three tracts, the Arnold St., River St. and the Baker Basin tracts. The first and last tracts were further subdivided into three areas each, thus making seven areas with about 36 houses to an area. The landscape architecture suggests a well formed design throughout, with a logical and systematic layout, taking advantage of the natural grades for economy. The houses were designed for permanence, the rooms were well formed, giving plenty of closet space and suggesting compactness, neatness and economy. The color schemes of the exterior walls and the roofs will present a very pleasing effect when completed. The United States Housing Corporation, through its architect, its landscape architect and the city engineer, designed the houses, laid them out in proper coördination and designed the public utilities. These plans were all ready when the contractor made up his estimate.

The detailed estimate, with its fine subdivisions into every kind of material that goes towards the making of a single house, was such that at a glance the entire aggregate of commodities could be taken off from a list. This was no small part of the job. As there were 28 different types of houses in the project, each commodity—such as concrete, boarding, rough framing, brickwork, shingles, etc.—had to be itemized per type of house and summarized both for the group of houses and the total number of houses. This was accomplished with the help of the corporation's field cost engineer. As a general rule, a contractor, in bidding on any construction project, does not go into minute detail but rather bunches groups of work. It was therefore a departure from the ordinary methods of the contractor's estimating department. As an example of the fine subdivisions, the rough framing had to be divided in the different sizes and different lengths and spread over the 256 houses, giving the number of pieces of each length for each type number.

The contractor's organization of forces followed the axiom that a triangle is safer standing on its base than on its apex. In other words, the scheming of the contractor's organization was done in such a way as not to make it top-heavy.

The construction work was commenced Sept. 9, 1918, four days after the award of the contract and four weeks before the contract was signed. Excavation was begun immediately after a tent was pitched, emergency equipment and material were brought in by trucks, and first small gang of 15 men started. The contractor's force then consisted of a few labor foremen, one office man and the assistant works manager. From that day on the field organization as well as the office organization began to form.

September and October were the most trying times for a contractor in which to organize a working force. The weather was bad, extremely bad. The influenza epidemic in the neighborhood was on the upward climb.

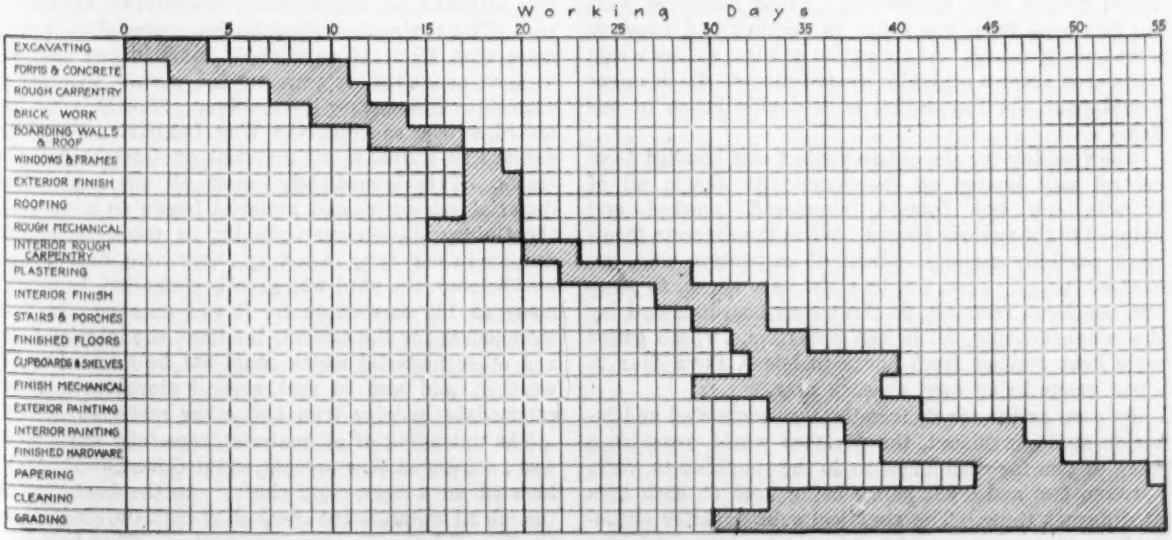
SHOWING RUNWAY OVER HOUSE FOOTINGS IN FOREGROUND TO FACILITATE OPERATIONS

taking its victims where least expected, and it took every ounce of energy to persuade the laboring class to go to the Quincy job at a wage scale that offered no inducements. However, in spite of all these difficulties, in three weeks' time an office organization consisting of approximately 30 employees and a field organization approximating 500 were gathered and put into working order toward a definite goal—rapid work, economical construction and efficient handling of labor.

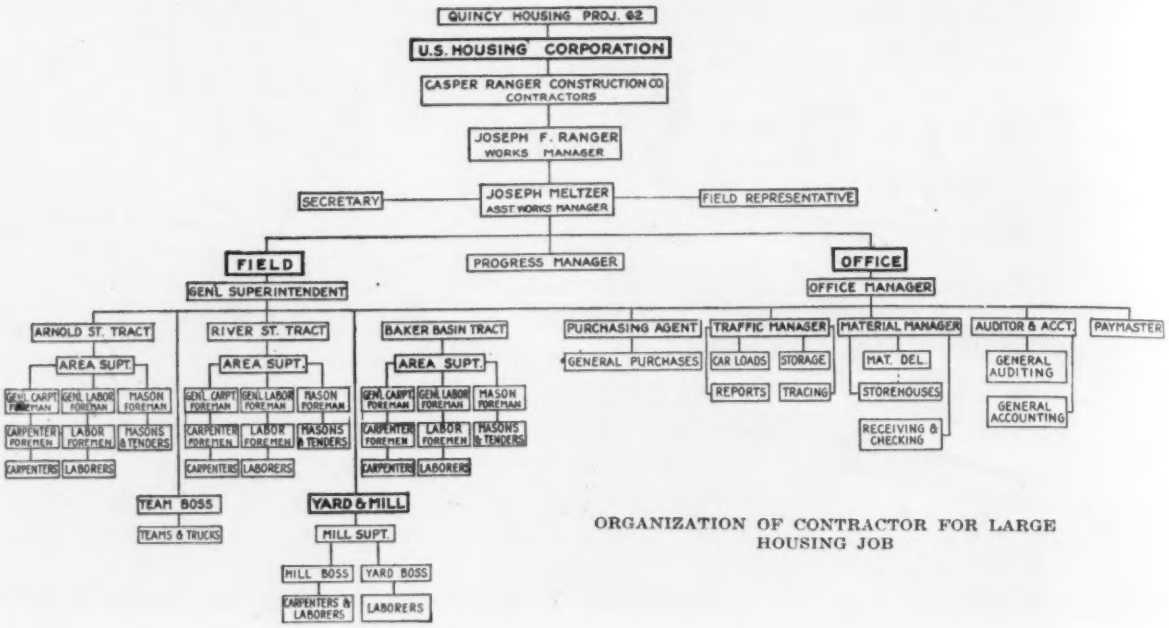
Gangs were organized to do excavation, other gangs were organized to do concrete work and still others were organized to place forms and to strip forms. These gangs followed one another in series, so that very little time was lost betwen movements. As soon as it was possible to remove the forms, the framework was started and brought to completion in very short time. Usually between eight and 10 men constituted a gang for placing the concrete work and from six to eight carpenters constituted a gang for putting up the framing and boarding.

The excavation on two of the areas was accomplished by horse scrapers and hand shoveling. On the Baker Basin tract, however, as well as in one or two instances on the Arnold St. tract, steam shovels were used.

Particular attention was paid to the top soil and subsoil with a view to saving every available square yard for planting and seeding around the houses. This was accomplished by using two horse scrapers and piling up the top soil and loam between the houses so that double handling would be avoided. The pressure of time, the inability to obtain the required amount of labor, and the rapidly approaching cold weather, hampered



HOW WORK WAS PLANNED ON ONE GROUP OF 15 HOUSES



ORGANIZATION OF CONTRACTOR FOR LARGE HOUSING JOB

the contractor in handling the top-soil excavation in the most efficient manner. However, taking everything into consideration, very little rehandling of the top soil was necessary. The excavation, which consisted in the main of gravel and sand in a proportion suitable for concrete aggregate, was effected by scrapers, plows and hand shoveling. Every possible bit of gravel that was fitted for concrete work was saved and used for that purpose.

Just as soon as a cellar would be completely excavated, the concrete footings for the walls were placed, mixed by hand or machine, and forms for the concrete walls were immediately set. Square-edged spruce and hemlock boards were used as well as tongue-and-groove North Carolina pine, although the writer prefers square-edged material. The concrete for the walls was mixed in one-batch gasoline-operated mixers mounted on wheels, which proved very economical. These machines were easily moved from one cellar to another and runways were quickly set up. At times two or three cellars would be poured from a centrally located mixer. Each mixer would pour the foundation of a double house in one day.

The framing for the entire project was handled from central mill located on the Arnold St. tract; all of it was cut and framed, numbered, marked and shipped to the various houses. When the concrete forms were partially stripped gangs of carpenters were organized, usually from six to eight to a house, to place the ready-cut framing, do the rough boarding and lay the rough flooring, all in one operation. These gangs were kept moving from house to house, from four to eight gangs being used on each area.

As soon as the rough framing was completed and interior studding placed, the plumber would organize a gang of two for each house to do the roughing-in work, between two and eight gangs being used on each area at different times. The electrical subcontractor organized similar gangs, working in conjunction with the plumbers and getting the houses ready for lathing and plastering. The sequence of operation after the lathing was in place—such as plastering, hanging sash, interior finish, finish flooring, etc.—was kept up systematically, so that each gang followed another with very little loss of time.

The public utilities being handled under a separate contract and installed by a different contractor, it was in most cases done in such a way as not to hold up the work. The public-utilities contractor used a large steam trencher for excavation for his sewer and water pipes throughout the job. In only a few instances was hand shoveling used. His work embraced the sewer, water and gas piping, and road work from subgrade to finish grade and granolithic sidewalks.

A difficult problem presented itself in the proper scheduling of the material so that commodities would all arrive consecutively and as needed. As the project was situated, all the material necessarily arrived by rail. The contractor scheduled his material so that no more than 15 or 16 cars would come in one day, and in such quantities as were needed weekly, in order to eliminate unnecessary rehandling. Shortly after the award of the contract the War Industries Board organized to purchase all material on Government contracts. This immediately upset all the contractor's material schedules, and material began to pour in at the Quincy station very rapidly, as many as 35 cars coming in one day; in a very short time, due to labor insufficiency, the yard was greatly congested, holding as many as 105 cars at once. It was necessary to build storehouses for the cement, the lime, the interior finish and other material which could not be exposed to the weather, and also to rent several storehouses to accommodate interior trim and other material.

The unloading of all material, especially the lumber, was a somewhat slow process, as the Government officials insisted on a very close check. At the beginning of the job all material was checked by both the contractor's checker and the Government checker. This was later eliminated and brought down to a more businesslike

basis by employing experienced lumber surveyors, and on the whole the unloading was considerably speeded up. All the material was delivered by motor trucks, and all the lumber except lumber for forms was delivered to the mill lumber yard and distributed in piles according to sizes and lengths, as is customary in lumber yards. The cement and the lime were stored in temporary and rented storehouses when these materials arrived in larger quantities than were immediately needed on the different areas. However, whenever possible these perishable materials were delivered directly on the job from the cars, to fill requirements. The other material, such as shingles, roofing, brick, etc., were delivered directly to the house lots in the quantities called for on the official estimate. All standing finish, doors, sash, etc., which had to be protected from the weather, were temporarily stored and then distributed to the different house lots to fill requirements. The central mill was equipped with electrically operated equipment, among which were the following: Two cut-off saws, three band saws, four circular saws, one bed planer, two buzz planers, one miter and other apparatus to make the mill complete. As a necessary adjunct the mill was equipped with a saw setter's outfit, grinders, emery wheels, etc. The mill proved a very profitable unit and decreased considerably the cost of framing and handling. The entire framing for each house was properly scheduled by an experienced man, thus eliminating the duplication of effort and the possible waste of lumber.

ACCOUNT		UNIT	COST FOR PERIOD			COST TO DATE		
			QUANTITY	UNIT	TOTAL	QUANTITY	UNIT	TOTAL
1 W (Arnold Street)								
11.3	(Perf)Rgh.Grading	c.y.	910	1.15	1063	9546	.73	6978
12.11	Excavation	c.y.	616	3.22	2428	12174	2.28	27745
13.111	Sub.Conc.Forms	s.f.	15716	.12	1911	194407	.11	21779
13.112	Sub.Conc.OtherWrk.	c.y.	187	4.50	1021	3111	3.84	12030
13.24	Super BrickWork	M.	84.6	39.08	3525	187.5	41.85	7815
13.34	Tile	s.f.	---	---	---	8097	.15	817
14.1	Carpentry,rough	m.b.f.	197.4	23.96	4736	822.9	30.44	25047
14.2	ExteriorWork.	1%	7% Complete	22.84	1484	13% Complete	22.84	2812
14.3	Interior "	1%	---	---	---	---	---	---
15.6	Roofing,Asphalt	sq.	46	3.19	211	46	3.19	211
16.	Sheet Metal	1%	21% Comp.	3.56	75	21% Comp.	3.56	75
17.1	IronWrk.Struc.	1%	5% "	5.98	390	9% "	5.98	572
18.2	PlasteringInt.	sq.	---	---	---	---	---	---
19.	Plumbing	1%	8% "	88.66	387	15% "	88.66	1400
20.	Heating	1%	20% "	20.84	275	25% "	20.84	527
21.1	Lighting,wiring	1%	9% "	23.58	225	32% "	23.58	771
22.1	Floors,Concrete	s.f.	4425	.06	262	4425	.06	262
22.3	Floors, wood	s.f.	---	---	---	---	---	---
25.1	Painting, ext.	1%	3% Comp.	35.25	98	3 Comp.	35.25	98
25.2	Painting, int.	1%	---	---	---	---	---	---
30.	Cleaning Up	1%	22% "	25.50	543	44% "	25.50	1136
26.3	Vit.Pipe, Drains Dry wells	1%	Less than 1% Complete		13	27% "	18.38	497
				TOTAL	17789		TOTAL	110802
		Note:	Item 12.11 (Excavation) includes rock and wet excavation. Item 14.1 and 14.3 (Each Group) Rough and Finish Hardware included					

FACSIMILE OF PROGRESS COST RECORD, SHOWING FINE SUBDIVISIONS

Unqualified Men Called Themselves Carpenters

One must remember that the laborer who applied for a job during the months of October and November was not a building laborer. Owing to the second Army draft men of all classes and of all occupations sought Government employment so that they might be classed as employed in an essential industry. The project at one time was overrun with tailors, waiters, farm hands and quarrymen, a class of labor which had to be sifted. The turnover on the job, therefore, was immense. In the carpentry line such difficulties were not encountered, but, owing to the many cantonment jobs that were in operation during the previous 15 months, many helpers classed themselves without right as carpenters, which only necessitated their expulsion after a few days' trial.

All this necessarily made for higher cost of construction, and it was only through the careful watchfulness of the individual foremen that the cost was held down to the lowest possible margin.

The progress department would report progress each day on each individual house, also the kind of work performed each day on each individual house. The same department kept a perpetual chart showing the gradual progress. These reports were submitted to the assistant works manager, who would chart each day's work graphically and numerically. By this method constant watch was kept on the cost of the job, the size of the organization, the progress of the job and the ratio of output to cost. In a word, it was the intention and aim to follow up the work as if the entire job was a big machine shop where maximum output and minimum cost are the aim.

In order to create coöperation and friendly feeling between the heads of the departments and a high *esprit de corps*, weekly organization meetings were called. At these meetings the results of the past week's work were discussed, criticisms were made promptly, and everybody present was urged to clear himself of all difficulties confronting him. Thus, each head acquired a view of the workings of the other departments and a proper perspective as to his place in the organization and the necessity for working in harmony. These meetings proved very beneficial to the job.

Among the Government's representatives were H. G. Ganson, traveling superintendent, and Walter H. Cook, project manager. Both proved to be of material help not only in their practical advice but in their hearty encouragement. The architect for the job was James E. McLaughlin of Boston. The landscape architect was Herbert J. Kellaway, and Ernest W. Branch was the engineer. The Casper Ranger Construction Co. was the general contractor, for which the writer acted as assistant works manager, having complete charge of the operation until Jan. 1. Joseph F. Ranger acted as the works manager. The entire work was done on the basis of actual cost plus a fixed fee. The approximate estimate of the cost of the work was $1,600,000, or about $3500 per house. This did not include the utilities such as water-supplies, sewers, streets and sidewalks, which were let under a separate contract to Dennis E. Crowley of Quincy, Mass.

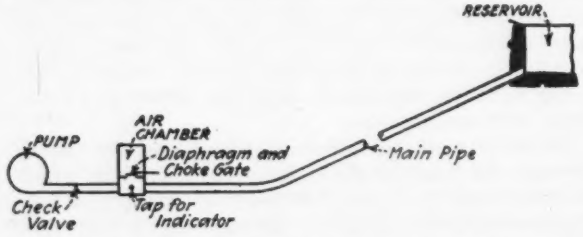
Graphical Records of Surge Pressures in Pipe Lines

Tests Made to Determine Effect of Varying Air-Chamber Conditions and Changing Choke Gate Area

By Ralph Bennett
Los Angeles, Calif.

NUMEROUS curves showing the actual effect of varying the conditions on two pipe lines equipped with air chambers have been made by an apparatus which produced a time-pressure record of the variations which took place at shut-down in these pumping lines. Results of a series of surge tests on these 18-in. and 24-in. lines are given. As originally installed, the 18-in. line was equipped with a plain air chamber, while the 24-in. pipe was without any protection against shock. The test results for the 18-in. line were used to design the air chamber for the 24-in. line.

In order to secure a continuous record of actual pressure variations, the pencil mechanism of a steam indicator was so arranged that it produced its mark on a strip moved by the clockwork train taken from a high-speed recording voltmeter. The machine, though difficult to set up, gave sufficiently accurate records for the purpose. It was subject to the usual disadvantages of the steam indicator when used on water. Thus, it is probable that the shoulder seen on the trailing end of the waves is due to piston lag, since at that point in the stroke the piston would have been riding quietly in the



GENERAL ARRANGEMENT OF TEST APPARATUS

cylinder and so may have stuck slightly. Minor variations in the paper speed also occurred, as the indicator pencil dragged more on the chart than did the original voltmeter pen.

Inasmuch as the energy stored in an air chamber is a function of the volume and pressure of the contained air and not of the shape of the chamber, the volume has been used in referring to the air effects. Sufficient data as to the conditions are given to permit of translating to other units.

The curve-tracing device was connected at the base of the air chamber, as is shown in the accompanying sketch, the reading being the pressure of the line. In one case the instrument was transferred to a point above the diaphragm to obtain a record of tank-pressure changes. This has been superimposed on the pipe-line record in an otherwise similar test (Fig. 9.) The curve is very interesting in that it shows graphically the time and intensity relation of the internal and external pressures when an almost perfect damping is attained in a single swing.

The vertical scales shown on the curves are those corresponding to the spring used. Owing to indicator friction as well as secondary pressure disturbances, the actual peak values may vary considerably from the curve value. The horizontal scale of time must be averaged, as minor irregularities of drum movement affected the record. The time given for the waves is that of the half wave after shut-down is complete and the column is vibrating as a free but loaded pendulum.

RESULTS OF TESTS OF 18-INCH PIPE LINE

Volume of air, cu.ft.	Pressure wave amplitude from starting pressure plus Lb. per square inch	minus Lb. per square inch	Time of half wave Sec
0	—	—	2.36*
14	36	25	3.12
20	32	23	3.65
35	26	19	4.75
50	23	16	5.83
75	19	12	6.5
100	16	11	7.4
118	16	9	7.0

*This figure is calculated; all others are observed values.

The lines were supplied by motor-driven centrifugal pumps, directly in line with the main pipe and but a few feet beyond the air chamber, and equipped with squirrel-cage motors controlled by oil compensators. As the rotating elements of such units are very light, the shut-down caused by opening the oil switch was as nearly instantaneous as can be obtained. The pumps had check valves which closed at about the point of flow reversal.

Tests were first made on the 18-in. line, and from them the necessary data for a proper tank on the 24-in. line was secured. This 18-in. line was of riveted steel, as follows: 0.0625 in. thick, 971 ft.; 0.078 in. thick, 816 ft.; and 0.1094 in. thick, 1400 ft.; average thickness 0.087 in., total length 3187 ft. The maximum head was 240 ft. (104 lb. per square inch) and the grade uniform, with no sharp bends nor obstructions. No laterals were open during the test. The pipe terminates in the bottom of a reservoir 150 ft. across and 12 ft. deep.

The air chamber at the pump is 36 in. in diameter and 10½ ft. long above the line, which passes directly through it. The two-stage centrifugal pump, delivering by test 954 gal. per minute, gave a line velocity of 1.2 ft. per second. A swing check valve was used.

Shutdown tests were made on this line, using varying quantities of air in the chamber. No provision for contracting the entrance to the air chamber was available, and it was not possible to vary the flow in the line.

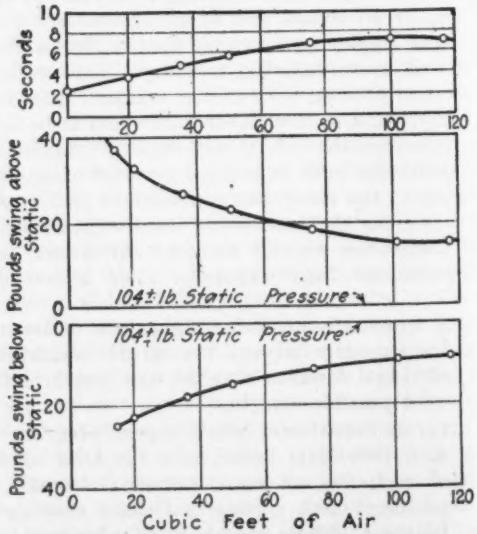
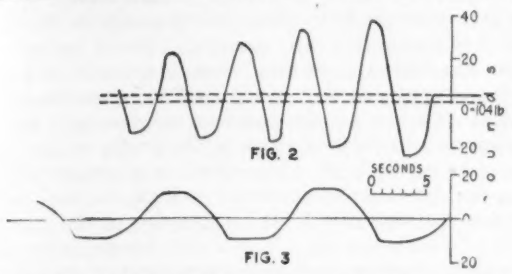


FIG. 1. PRESSURE VARIATION WITH AIR VOLUME—18-INCH PIPE TESTS

The results of these tests are given in the table and by the curves in Figs. 1, 2 and 3.

The data on the 24-in. riveted-steel pipe line are as follows: 0.078 in. thick, 4757 ft.; 0.109 in. thick, 1954 ft.; and 0.172 in. thick, 80 ft.; average thickness, 0.086 in., total length 6791 ft.; maximum head 160 ft. (70 lb. per square inch, including friction); grade uniform and without sharp bends or obstructions; no laterals open during test; pipe terminates on the bottom of a reservoir 100 ft. in diameter and 10 ft. deep.



FIGS. 2, 3. GRAPHS FROM TESTS OF 18-INCH PIPE LINE
Fig. 2, air, 14 cubic feet; Fig. 3, air, 118 cubic feet.

The air chamber is 48 in. in diameter, with 15 ft. effective height, connected to the line through a rectangular opening in a plate diaphragm which can be closed by a slide. Water is supplied by a two-stage centrifugal pump delivering by test 1881 gal. per minute and producing a line velocity of 1.33 ft. per second. The check valve on this pump was an egg-shaped plunger controlled as to speed of closing by a bypassed plunger.

The free action was as rapid as that of a swing check. Most of the curves were obtained with little or no retardation of this valve. Experiment proved that delayed action resulted in additional shock if the water column had reversed before the valve acted.

Tests on this line were made for numerous volumes of air, using also many different choke openings. The calculations had shown that the 24-in. line could be held to a rise of less than 10% of normal by an air chamber having an air space of about 65 cu.ft. connected to the line through an opening of 30-sq.in. area.

Fig. 4 shows the card obtained with 67 cu.ft. of air and a 25.87-sq.in. choke. Under this condition, the fall of pressure at shutdown is very severe, and the oscillations die down very quickly. The condition desired is one in which the greatest possible absorption of energy occurs across the choke from the instant of shutdown. The best condition occurs when the first half wave (in this case negative) is the one in which the greatest loss occurs. The ability of the line to stand reduction in pressure will frequently limit the possible control.

Note on this curve the great distortion of the fundamental wave by the shock from the check valve. This superimposed pressure may at times become very serious, but, as stated above, any attempt to control it by slow valve action is a move in the wrong direction. Better results would be obtained by a loaded valve.

Fig. 5 was obtained with the same air content, 67 cu.ft. and a 32-sq.in. choke. The check-valve disturbance is much as before. The indicator was put on the line before the pump was started, and the entire cycle from standstill to standstill is shown. Note that the shock due to the rapid start of the pump is more severe than is that due to the shutdown surge.

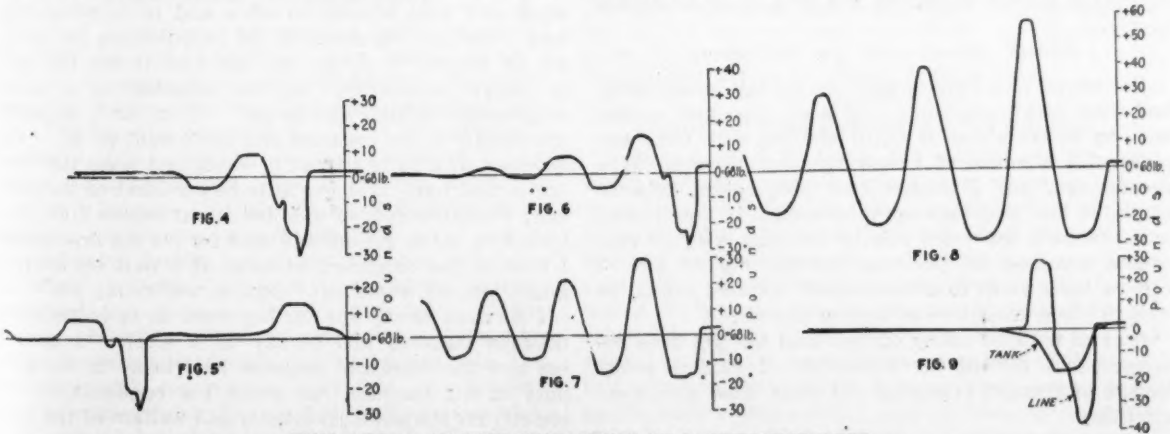
The quantity of air and the closeness of the choke can be varied within limits with about the above results, but any considerable decrease in the amount of air reduces the ability of the tank to absorb energy and increases both the pressure peaks and the number of undulations required for full absorption of the energy in the water. Curves in Figs. 6 and 7 show these effects very clearly. Fig. 6 shows good control with 35-cu.ft. air and a 25.8-sq.in. choke, while Fig. 7, with the same volume, produces an excessive shock.

If the tank contains ample air but is too freely connected to the line, a condition results similar to that shown in Fig. 8, which was taken when the air supply, 90 cu.ft., was more than ample for full pressure control but with an excessive opening, 68 square inches.

Inasmuch as the commonest danger to ordinary pumping lines and to most water-wheel lines is due to excess pressure, most attention is directed to the effect of the upward surge. But the pressure limiting work is most effectively done in the first downward swing, as noted above, and the safe reduction in pressure is the usual limit to the control.

While the condition of full-load shutdown is more apt to occur in pumping lines than in wheel-penstocks, yet the effect of governing is of vital importance in the latter case, and a choke air chamber will be beneficial on any change of velocity.

The equations used in working up the air-chamber capacity and the choke areas required took account of



FIGS. 4 TO 9. GRAPHS FROM TESTS OF 24-INCH PIPE LINE
Fig. 4, air, 67 cubic feet; choke, 25.9 square inches. Fig. 5, air, 67 cubic feet; choke, 32.0 square inches. Fig. 6, air, 35 cubic feet; choke, 25.8 square inches. Fig. 7, air, 35 cubic feet; choke, 45.0 square inches. Fig. 8, air, 90 cubic feet; choke, 68.0 square inches. Fig. 9, superimposed tank and line pressures.

the elasticity of the water and of the pipe, but not of the effect of internal friction in the air. It is probable that large and important tanks would have to be figured with due allowance for all losses.

The lines tested were connected with plants supplied with energy by the Southern California Edison Co., and the company's apparatus was used in making the tests. R. J. C. Wood of the company acted with the writer throughout the work, and to his unusual ability in this class of work are due the results obtained.

Coming Status of the Employee in Industry

Advantages of Stock Ownership by the Workers—Duty of Industry to Society in Developing and Protecting the Men

The following paragraphs on the future status of the worker in American industry are taken from an address by Charles F. Lang, president of the Lakewood Engineering Company, before the annual convention of the National Machine Tool Builders' Association in Atlantic City, May 12. He points out the advantages of stock ownership by the employee, and credits the employee with the ability to exercise a salutary influence upon the management of the company. He also points out the duty which industry bears to society for the "health, mentality and welfare" of the worker—EDITOR.

WITH the financial inflation which this war has made necessary, with the world-wide shortage of labor, with the shelves of the world empty, America, with one-third of the world's gold, with her finances in splendid shape, with her tremendous productive capacity, with her marvelously productive labor, and with a less acute labor shortage than any other country in the world, can and should and will face the future with absolute confidence, for it cannot be doubted that she is entering upon a period of unusual prosperity and opportunity such as has never before come to any nation. One of the first things Noah did after the flood was to get drunk. And America's greatest danger for the future is that she may become drunk with power. She must enter this new era with certain principles and ideals or she will not realize her opportunities, and one of the greatest of these ideals is that there shall be such a distribution of wealth among all her citizens as will make for the happiness and well being of all her people.

PROFIT SHARING TO BE UNIVERSAL

Far-seeing men have already sensed this opportunity, and these ideals are being expressed—yes, and carried out—by business men in their relations with their employees in a spirit of coöperation not dreamed of a decade ago, and I predict that coöperation between employer and employee—profit-sharing, if you please, will become a universal rule of business with all successful concerns in less than another decade, and, I believe, with profit to all concerned, invested capital as well as labor, executive as well as laborer.

No real national policy of this kind has yet been developed, but toward the formation of such a policy leaders of thought in capital and labor must give their attention.

I am proud of the spirit of the present generation which is so earnestly thinking along these lines. The present form of corporation so readily lends itself to securing this coöperation that it is rapidly becoming a habit for American business concerns to encourage their employees to purchase stock in the company, but I fear the employees are not as rapidly as they should accepting this opportunity to share in the profits of the business for which they are working. But I believe the time is rapidly approaching when there will be a real partnership all the way down the line, when the stockholders of many of our business concerns will be the employees, and those sharing in the profits of the business (the more thrifty, of course, to a greater degree than the careless and shiftless) will be the men working for the concern. I see no dangers in the development of such a system. It is a well known, but nevertheless interesting, fact that your average stockholder never shows up at a stockholders' meeting unless his dividends are cut, and I don't believe the employee-stockholder will be a very much different kind of an animal, except that if he does become alarmed because his dividends are cut he will try to find the reason why, and may discover that he himself, because of the kind of service he has rendered his company, is one of the reasons for this, and that a lot of his fellow workmen are others of the reasons, and that between them they will try to discover a way, by more efficient service, to avoid a repetition of the unfortunate circumstance. It has never seemed very difficult for the American people to select the right man as their chief executive, and it is remarkable how few mistakes have been made in this direction in American history. In the democracy of business I think just as few mistakes will be made by the stockholding employees in the selection of various executives. In other words, peculiar fitness for particular responsibilities seem to be quickly and intuitively recognized by the American people, whether in their national affairs or in their business affairs. (More particularly, perhaps, in their business affairs, for I am inclined to agree with an official of the Chinese government who was over here not long ago and who raised the question as to why we did not require our congressmen to take an examination as to their qualifications to serve before we elected them.)

ADVANTAGES OF EMPLOYEE STOCKHOLDERS

I submit that a system whereby the employees are stockholders might be far better than the present one, where, perhaps, an individual owning the majority of stock will keep himself in office and in responsibility long after his usefulness to the organization has gone, for he himself is always the last man to see this and to resign voluntarily. As the president of a large corporation recently said to me: "I am not a majority stockholder in my company and don't want to be. I do, however, own quite a block of stock, and when the time comes that I am no longer fit to be president of the company the other fellows will find it out before I do, and by asking me to get out will save for me the investment I have in the company; whereas, if I wait too long, I might lose my whole investment as well as my job."

I do want to say one further word as to coöperation between business and society as a whole. I cannot see how the American business man today in the conduct of his business can avoid his responsibility to society, for the health, mentality and welfare of the men employed in his institution. And I do not say this with any paternalistic idea in mind; it is, rather, a patriotic duty, and not a fatherly kindness. For, if all our men

are kept in health and happiness, due to proper and pleasant working and sanitary conditions, their productivity is increased, thereby increasing the national wealth and comfort.

Again, getting down to fundamentals, every workman dying before his time, because of the unhealthful or unsanitary conditions under which he is compelled to work, and leaving behind him a family for which he has been unable to provide a competence, merely represents another one of those losses which must be borne by society as a whole, which means that each individual member of it must bear his proportion. This is entirely aside from the sentimental and humanitarian side of the problem.

Again, it is the duty of the employer as well as the employees to compel such of the employees who neglect to do so, to live and bring up their families under clean and sanitary conditions of both mind and body—of both *mind* and body—for no employee has the right to endanger the health or happiness of his fellow employees, however careless he may care to be about his own.

These remarks apply with greater force to the the development of the mentality of the men. Low mentality makes for social unrest. We Americans are too apt to complain of the ignorance and lack of judgment of workmen, when, as a matter of fact, the responsibility for that ignorance is upon ourselves.

America Can Solve Industrial Problem

The Chaldeans, I believe, were the inventors of books; the Greeks left us a heritage of art; Rome gave to the world standards of law and organization which are still followed; the daring navigators of western Europe carried through a marvelous period of discovery; Germany, with all her faults, has given to the world many wonderful advancements in science. I cannot but feel that America will leave as her heritage a solution of the problem of the proper distribution of wealth and happiness and education among the masses; in other words, will show to the world how a government can truly be a government "of the people, by the people, and for the people," because the people are capable of making it that kind of a government.

Iowa Assembly Had 25 Occupations Represented—No Engineers

Although 25 different occupations were represented in the late General Assembly of Iowa, there was not a single representative of the engineering profession among the legislators. This fact was ascertained from J. H. Dunlap, who compiled the list of occupations in the course of the campaign for the passage of the engineers' registration bill. The professions and trades represented were as follows: Bankers, farmers, manufacturers, merchants, lawyers, druggists, coal and ice dealers, lumber dealers, investment salesmen, grain dealers, school principals, publishers, stockmen, auditors, physicians and surgeons, college presidents, editors, students, real-estate dealers, insurance agents, commercial travelers, teamsters and switchmen. In Professor Dunlap's opinion, the fact that no engineer's name appears reveals the common lack of interest in community affairs which the engineer is just beginning to realize is responsible for much of what he is criticizing in his present professional position.

A. A. E. Compensation Committee Report

IN A report on compensation made at the recent annual convention of the American Association of Engineers the following conclusions, on which to base a salary schedule, were reached:

1. That the profession of engineering, taken as a whole, is insufficiently paid, or is not paid in proportion to the high degree of responsibility entailed or the technical training required to perform the work.
2. That the principle of a square deal for everybody should underlie all rules of compensation, and that technical men must demonstrate their worth both to their employers and the public before they receive the compensation due them.
3. That this demonstration should be made by individual salesmanship, and by proper methods of publicity directed by this association to establish coöperation between employers and employees and to insure proper recognition of the services of the engineer by the public.
4. That while salesmanship may produce results in individual cases, it is necessary to operate collectively for the rank and file of engineers, and desirable that some forms of grades for engineering services be adopted with a minimum rate of pay for each grade.
5. That the rates suggested herein are not the maximum standards, but rather indicate the rate of pay of anyone who can perform the line of work, and that individual effort should be encouraged to the fullest extent and be paid accordingly.
6. That in the determination of a just compensation, consideration must be given to the effort or cost of the educational training; the years and character of experience in the particular line, as well as total years experience; length of time in employer's service; character and personality; degree of efficiency and special qualifications.
7. That the uncontrolled law of supply and demand is not a just method by which to determine the compensation for valuable services. Therefore, steps should be taken to control its operation so that it may not become oppressive especially in the lower grades of service.

The following specific recommendations were made:

1. That the hours of employment for technical men of grades 1, 2 and 3, hereafter defined, should not exceed eight hours per day or 48 hours per week.
2. That overtime in above grades should be paid for at an increased rate.
3. That no one in charge of engineering or construction forces should be paid less than any man for whose work he is responsible.
4. That when by a superior's orders an employee is shifted to a point requiring him to change his place of abode, the employer should bear the entire expense of moving him and his family.
5. That employees should be given national holidays and not less than one day's vacation for each month employed during the year, and that provision should be made for disability due to the hazard of employment.

California Road Repairs and Vehicle Fees

A large part of the money for maintaining the California state highways is derived from motor-vehicle license fees, which are, in general, on the basis of 40c. per horsepower per annum, with an additional fee based on weight for those trucks which use other than pneumatic tires. The fees collected are used first to pay the expenses of the motor-vehicle department, after which the balance is equally divided between the state and the several counties, to be used solely for road work. The half going to the counties is apportioned among them on the basis of the amount received from the residents of each county. In California at the beginning of the year there was a total of 300,000 motor vehicles, or one for every 10 persons.

Motor Equipment of United States Army Engineer Corps

Motor Truck Adapted to Many Purposes — Portable Carpenter, Machine, Blacksmith and Printing Shops and Searchlights

WHILE it is well known that motor trucks have been adapted to many purposes by the Corps of Engineers of the United States Army during the war, ocular demonstration of the facts had been largely withheld in this country until the recent parade promoting the Victory Loan in New York City. Devices exhibited in this parade demonstrated the great flexibility of the motor truck as a tool and suggest similar adaptations in civil pursuits. Such equipment might easily be of service on any widely scattered construction or maintenance operation, where it would be advantageous to make repairs *in situ*, rather than convey the part to and from machine shops. Portable tool trucks and sleeping quarters for small maintenance and construction gangs are also suggested.

The pictures given herewith are fairly representative of the various uses to which trucks were put. Beside those shown, other applications of the truck to war purposes may be mentioned, as follows: Water-purification plants; airplane transportation trucks; motor kitchens; motor bath-houses and ice machines.

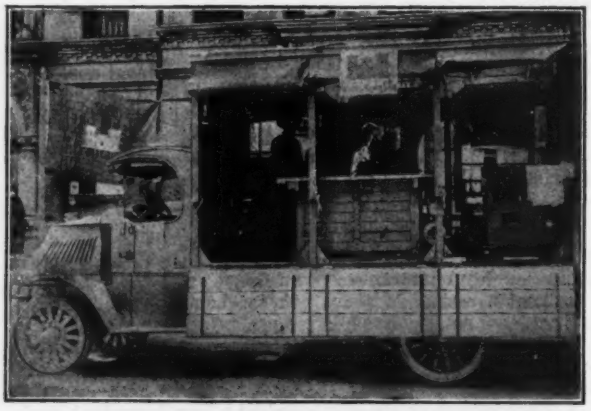


FIG. 1. PORTABLE CARPENTER SHOP WITH SIDE OPEN

In addition to the devices named there are, of course, the transportation trucks and the fighting machines such as tanks and artillery tractors, which may be considered as motor-transportation features developed by the war.

That efficiency as well as flexibility characterized practically all the motor apparatus used in France may be seen from the following statement made by Maj. George A. Green, assistant chief engineer of the tank corps of the British Army and, before the war, chief engineer of the Fifth Avenue Coach Co., of New York City. He stated before the first semi-annual motor-transportation conference held at the Colt-Stratton Building, New York City, that during 18 months' service in France, all of which was in the forward fighting area, he had not seen a single motor truck broken down from other causes than ditching and direct hits by shells.

Already many special peace-time motor installations have been developed, particularly in municipal and

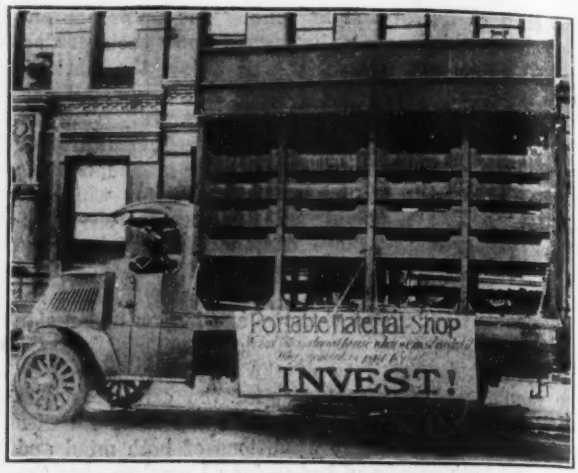


FIG. 2. MATERIAL TRUCK CONTAINS 600 ITEMS OF TOOLS, SUPPLIES AND OTHER EQUIPMENT

street work. It is thought that the successes along this line in warfare will stimulate additional experimentation in the use of trucks for special purposes.

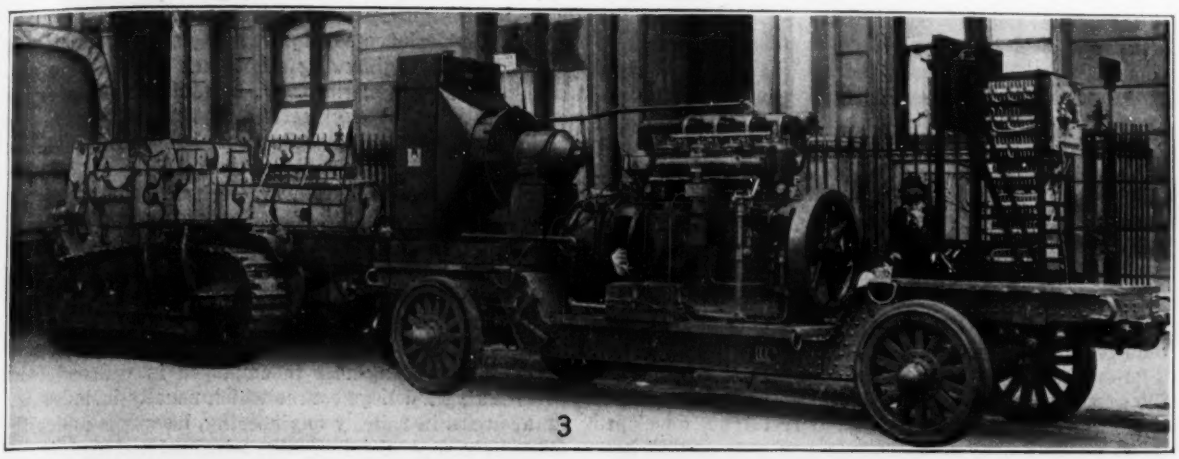
In all the special trucks developed by the Corps of Engineers, compactness is the chief characteristic. The necessity for this may be seen when it is stated that some of the portable shops contained as many as 10 different pieces of machinery, while the complete list of machine tools and supplies ran as high as 800 pieces. To get this all on one truck required the utmost economy in arrangement. When the war ended there were 95 of these portable shops in the service and 30 material trucks. The chassis for the shops and material trucks were of 5½-ton capacity.

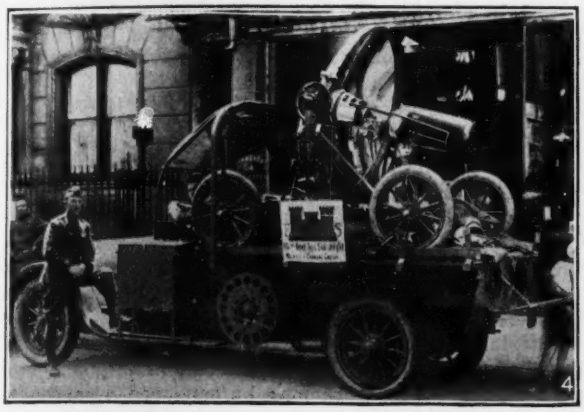
Among other devices developed by the corps, but which were not in service when the armistice was signed, is a small crane, for hoisting materials, mounted upon a motor truck so that it can move from place to place, and a portable pile driver which it is thought will be useful in highway and other construction where it is necessary to drive piles. The pile driver was designed to be drawn by horses, but it could easily be mounted upon a motor truck. While the pile driver is being transported, the leads, which are 30 ft. in height with a spread of 17 in., are folded up. The driver is operated with a 25-hp. gasoline engine, and can be placed in operation within 15 min. after arrival.

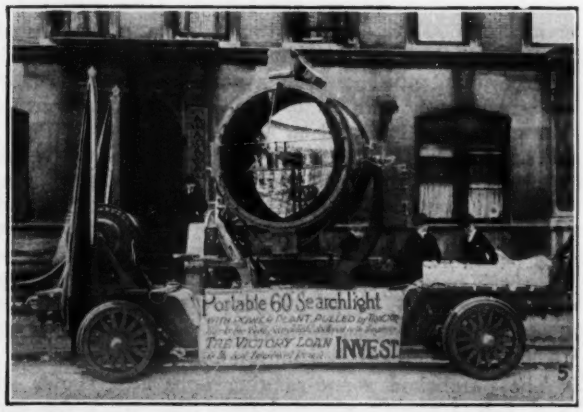
Referring to the pictures: The carpenter shop, Fig. 1, is arranged to do all light wood work. As shown, the side is let down and the curtain at the upper part is pulled up for working. It contains a boring machine, a drill press, a bench grinder, a work bench, a saw bench, a double-purchase winch, and a power plant and switchboard, besides the necessary tools and supplies. It costs, complete, about $8500.

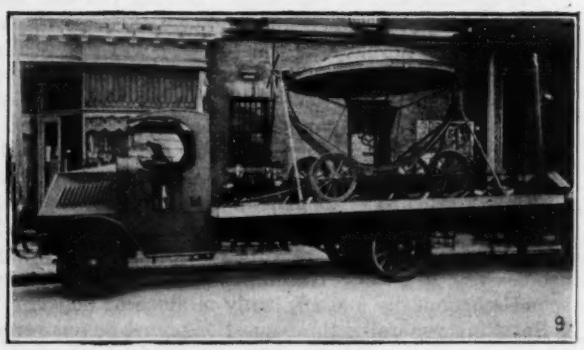
Fig. 2 shows a material truck with the side opened up for removing tools. Each truck contains about 600 items of tools and supplies. The height appears greater in the view than it actually is, because the upper portion of the sheet-iron side is folded up at the top. The sides are arranged so that they may be securely locked. The cost is about $8000.

Of the other portable shops, the machine shop, Fig. 6, contains a work bench, a drill press, a portable electric drill, grinders, an electric hammer, a 14-in. lathe, an









FIGS. 3-9. 3. TRACTOR AND SEARCHLIGHT POWER PLANT. 4. OPEN-TYPE 60-IN. SEARCHLIGHT ON TRUCK. 5. SIXTY-INCH BARREL TYPE SEARCHLIGHT, WORKS WITH APPARATUS SHOWN IN FIG. 3. 6. MACHINE SHOP. 7. BLACKSMITH SHOP. 8. PRINTING SHOP. 9. PARABOLOID SOUND-RANGING APPARATUS

oxyacetylene welding outfit with a power plant and necessary tools and supplies. The complete shop costs about $9500. The blacksmith shop, Fig. 7, is also used in handling plumbing and tin-shop work when necessary. It contains a work bench, a forge, hoists, a pipe-threading machine, a shear and punch, vises, a welding and cutting outfit and power plant tools and supplies. The cost is about $8000.

Fig. 8 shows a portable printing shop used in making maps. During the parade this shop was turning out two-color posters, 20 x 30 in. in size, advertising the Victory Loan. All the shops are electric-lighted.

Figs. 3, 4 and 5 show the various searchlight appliances used for detecting airplanes. Figs. 3 and 5 go *en train*, the tractor hauling the power house and the searchlight to any desired location. The searchlight is of the 60-in., high-intensity, barrel type, developed by the Corps of Engineers. It has a turntable base which is hidden behind the Liberty Loan sign. By means of 500 ft. of cable the light can be operated anywhere within that radius from the power plant. The power plant consists of a gasoline engine directly connected with a dynamo, and, like the searchlight, is permanently mounted on a trailer.

Fig. 4 shows a 60-in. open, high-intensity type of searchlight, which is mounted upon rubber-tired wheels, so that it can be removed from the small truck and operated within a radius of 500 ft. from the same. The power for running this searchlight is mounted in the truck back of the cable roll. This searchlight has 2,500,000 candlepower. Tests of the searchlight used in detecting airplanes have shown a 43% visibility at 15,000 ft. and an 85% visibility at 12,000 feet.

The paraboloid sound-ranging apparatus shown in Fig. 9 was merely mounted upon this truck for the purpose of the parade. It is used in testing the location of artillery by the sound of the explosions.

Colleges Should Play a Part in Highway Program

Weakness of Road-Engineering Courses Compared With Great Need for Trained Road Engineers and Material Inspectors

By R. L. Morrison

Professor of Highway Engineering, Agricultural and Mechanical College of Texas, College Station, Tex.

THERE is no single line of activity to which more public attention is being directed at present than to the development of highways. During the war the amount and importance of highway transportation greatly increased, but new construction was practically at a standstill and even maintenance was reduced to an absolute minimum. With the ending of hostilities and the removal of legal restrictions upon road work, plans were immediately made for an era of roadbuilding such as this country has never known before. What part are the colleges to play in this road-development program? Are they leading or directing the movement? Are they doing extensive research work on highway problems? Are they training highway engineers to spend economically and efficiently millions of dollars?

Speaking generally, these questions must be answered in the negative. Of the 126 engineering schools of college grade, probably not more than a dozen devote as much as five term-hours to highway engineering, or have their highway course given by teachers with any practical experience as highway engineers. Practically every leading engineering school has at least one specialist in railway engineering, in sanitary engineering, and in structural engineering, but the highway specialists are conspicuously absent. Is there sufficient reason why colleges should offer more than a two- or three-hour course in highway engineering, or why the instructors should have any broader knowledge than can be obtained by a study of the textbooks used by the students, when the colleges are already criticized for specializing too much in undergraduate work?

The branch of engineering which most nearly resembles highway engineering is railroad engineering. When a young engineer in employed in railroad work after taking a college course which usually includes several courses in railway engineering, he works under the immediate supervision of, say, a trained and experienced resident engineer, and no matter how limited the young man's knowledge of practical railroading may be, he has every opportunity to learn and cannot go far wrong.

Untrained Men in Charge of Work

On the other hand, the 2,500,000 miles of public roads in this country are very largely in charge of men absolutely untrained and inexperienced in highway or any other engineering work, and who are constantly changing as a result of political changes. That there is enormous waste of money spent on roads is known to everyone. Comparatively few roads are adapted to the traffic which they are called upon to bear, improper materials are often used, and the standardization of methods and types is just beginning. The young man entering highway work may be employed as a county engineer within two or three years after graduation, with no experienced superior to guide him, or he may be in charge of work for a state highway department and located miles from his superior. In the latter case the engineer under whom he is working may be as new at highway work as he is.

In no other field do so many engineers get responsible positions without previous experience in the work they are undertaking, and there is probably no other field which is attracting so many engineers at the present time. It would seem that this combination of circumstances alone is sufficient to justify the colleges in specializing in highway engineering.

Although there are of course many engineers all over the country who are thoroughly versed in all the details of highway work, there is also a large number who are called upon, for instance, to use large quantities of bituminous materials without having had any opportunity to make a study of such materials. They find that this is an extremely difficult subject to master without an instructor, so they use the materials by trade names only, or else they are forced to copy specifications which they do not understand and which may not be applicable to their particular conditions. If they wish to have intelligent laboratory control of their bituminous work, where they can find the necessary testing engineers? How many colleges are equipped to given adequate classroom and laboratory instruction in the subject of bituminous road materials? And if the colleges cannot train testing engineers, where do they come from? The answer is that as a rule they do not come.

In addition to training engineers, there is an opportunity for the colleges to be of great public service by giving "short courses" for local road officials who are not engineers. A few institutions have accomplished a great deal along this line, especially in coöperation with state highway departments. Valuable missionary work can also be done, especially in those states having the fewest good roads, by means of public lectures, bulletins, press articles, exhibits, etc. thus educating the public to appreciate and demand not only good roads but also proper methods of construction, maintenance, financing, and administration in general.

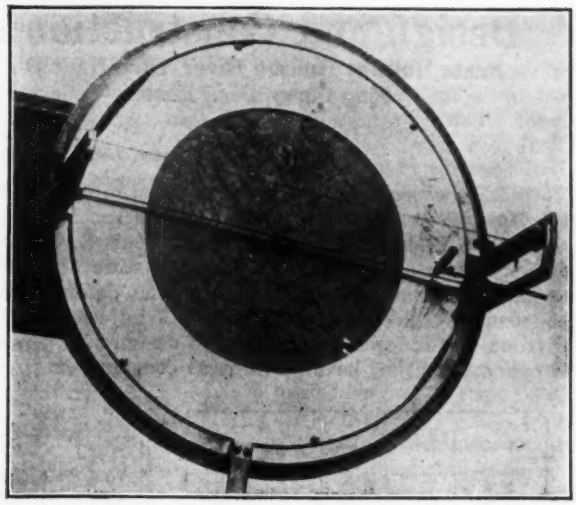
With this great opportunity before them, it is to be hoped that the engineering colleges will decide to do something more than turn out young men who are prepared to learn something about highway engineering, provided they can find someone to teach them.

"Fire Finder" for Lookout Stations of Forest Service

AN INSTRUMENT combining some of the functions of the plane-table and the transit has recently been developed for locating forest fires from the mountain lookout stations of the United States Forest Service. Enough of the instruments were manufactured in Portland, Ore., early in 1918 to equip many of the important lookout stations in the Northwest, and it is reported that they gave satisfactory service last summer. In some cases fires were accurately located at a distance of 50 miles. Acting on the good record in actual use of the instruments, the Forest Service has recently adopted it as standard. It is known as the Osborne fire finder, as it was developed by William B. Osborne, Jr., of the Portland office of the Forest Service.

The instrument head consists of two parts, a lower iron plate equipped with leveling screws and lock nuts, and an upper iron plate of 24-in. diameter which pivots on the lower plate and bears on its periphery a circle graduated to 15 min. To this upper plate is fitted a heavy iron ring which can be revolved independently and which carries front and rear sights and a vernier for reading the horizontal circle. The vernier is graduated to read to 15 min. The sights are of brass, the rear sight being slotted as in a surveyor's compass, with the addition of a fixed peephole, the front sight being open with a vertical horsehair. The apparatus for measuring the vertical angle of the line of sight is attached to the front sight, and consists of a perforated brass belt running vertically on spiked wheels and controlled by a milled wheel and pinion. This belt carries a pointer and an indicator set horizontally at right angles to the line of sight.

The indicator slides over an etched tangent graduation attached to the outer face of the sight and reading to minutes. The same pinion which moves the belt and pointer carries a cogged wheel for moving a pencil-bearing rack forward and backward across the upper plate of the instrument, but along the line of sight. This enables the observer to sketch the panoramic profile, the sketch being made on a ring of heavy white celluloid, 21 in. in diameter and 4½ in. wide, which is placed on the upper plate of the instrument. The pencil is held in contact with the celluloid by a spring, and the profile is sketched by the observer looking through the peephole in the rear sight, keeping the pointer and horsehair of the front sight on the skyline or other line to be sketched, and slowly rotating the sight-bearing ring.



AN INSTRUMENT DEVELOPED BY THE FOREST SERVICE, TO LOCATE FOREST FIRES

A map of the country under observation is fastened to the upper plate, beneath the celluloid ring before mentioned, the center point of the map representing the observation point. The instrument rests on a track mounted on a 1½-in. baseboard 28 in. long. The observer can move it along this track without disturbing the orientation or level, thus avoiding the posts of the lookout cabin that might obstruct the view.

In operating the instrument, the observer looks through the fixed peep of the rear sight and brings the pointer of the front sight to bear on the fire. The instrument being already oriented, he reads the azimuth of the line of sight on the horizontal circle and the vertical angle of the line of sight on the front sight graduation. He then obtains on the map of the locality a projection of the line of sight by means of a graduated steel tape which extends from the rear to the front sight. The zero of this tape is at the center of the map, and by the platting pencil he obtains the position of the fire on the panoramic profile.

The location of the fire is then determined by (1) platting the intersection of the lines of sight when the fire is reported from two stations; or (2) by using the vertical angle to plat the intersection of the line of sight with a profile or cross-section of the country along that line of sight; or (3) by estimating the location of the fire from its apparent position relative to other points which are platted on the map; or (4) by estimating the location of the fire from the position indicated for it on the panoramic profile, which latter estimate may be made at night when the features of the landscape are not visible.

Increase of Highway Costs in California

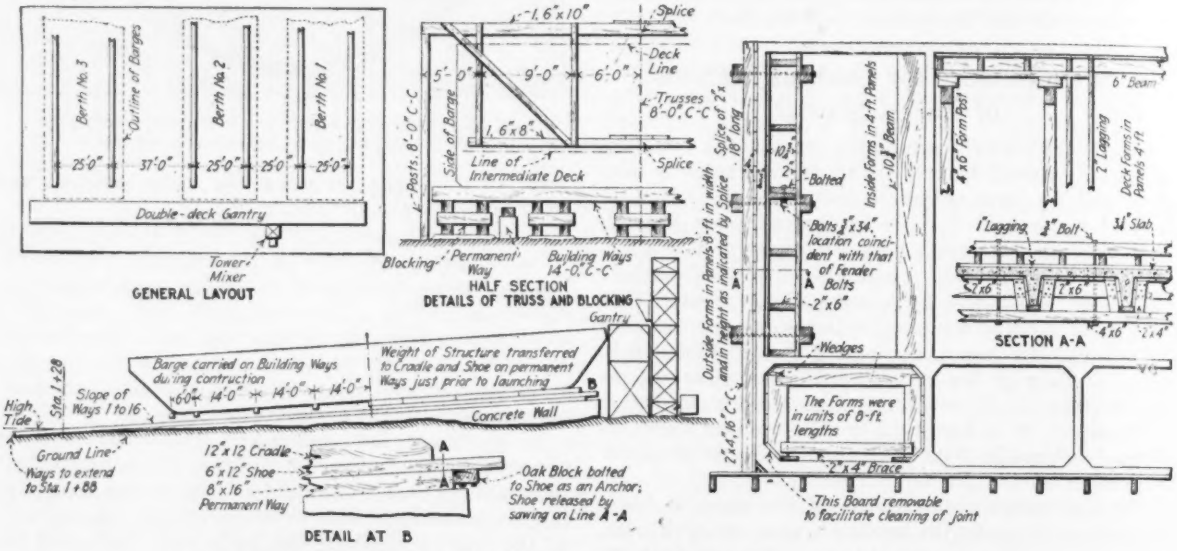
Highway costs in California did not change much in the period between 1912 and 1916, according to state highway officials, when the average cost of the standard concrete pavement, which was 4 in. thick and 15 ft. wide, amounted to $6200 per mile, exclusive of grading and culverts. In 1917, however this cost rose to $8400, and in 1918 the average was $10,800 per mile.

Design and Construction of Navy Concrete Oil Barges

Boats Built at Hudson River Yard Have Oil Holds Protected by Air Compartments and Also May Carry Deck Loads—Concrete Poured From Trestle at Rear of Boats

By R. M. Burkhalter
Engineer, Louis L. Brown Company, New York City

THREE concrete oil barges for the United States Navy were successfully built and launched last season at the Hudson River yard of the Louis L. Brown Co., at Verplanck, N. Y. These vessels were designed in general outline by the department, but details were supplied by the contractor. They are being used as oil carriers, and differ from the common design of concrete barges in that they have below-decks compartments for strong, rectangular frame which serves to transmit the deck load to the hull and to stiffen the boat transversely, corresponding to the strong frames in the usual marine design. Longitudinal strength is obtained by using fore and aft bulkheads. These bulkheads are 3 in. thick, stiffened every 4 ft. by vertical beams which extend down to the intermediate deck. Stiffeners were not considered necessary below the intermediate deck, since



FORM AND YARD LAYOUT FOR NAVY OIL BARGES BUILT AT VERPLANCK, N. Y.

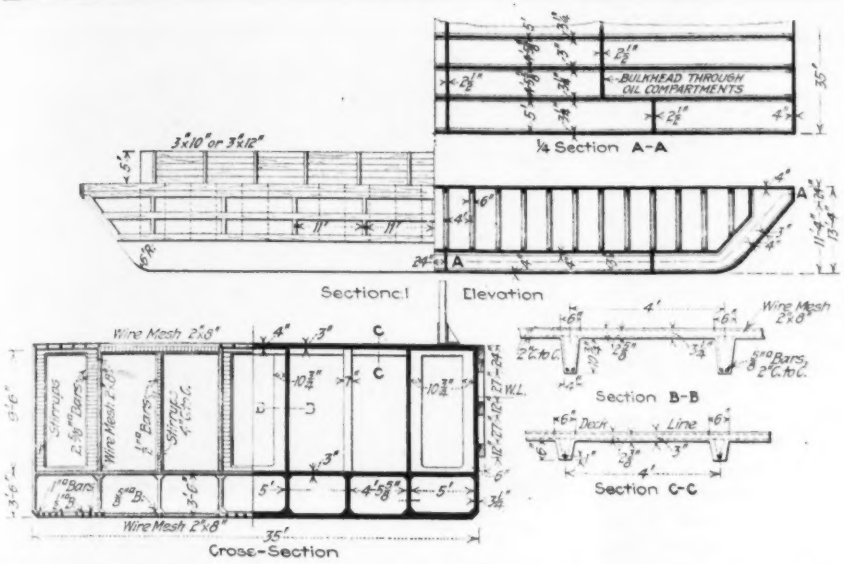
3000 bbl. of oil and a deck capable of carrying a 500-ton cargo, although both loads cannot be carried at the same time.

The principal dimensions of the barge are: Length 112 ft., beam 35 ft. and depth 13 ft. 4 in. As shown in one of the drawings, the barge has an intermediate deck below which six fore and aft bulkheads run the entire length of the barge. Above this intermediate deck are four fore and aft bulkheads which provide three spaces for oil compartments and two outboard compartments without cargo. By this arrangement an air compartment is everywhere provided between the oil compartments and the skin of the barge. There are, in addition, three transverse bulkheads above and below the intermediate deck, making a total of 32 separate compartments in the barge. The amount of cargo space and of air space below deck are practically equal.

The transverse frames, above the intermediate deck only, are 4 ft. c. to c. They consist of vertical beams of 10½-in. depth and horizontal beams of 6-in. depth so placed that the frames formed rectangles, three of which appear in the cross-section of the barge. The vertical members of these rectangles are beams receiving, through the slab, oil pressure or water pressure. The top members of the rectangle serve as deck beams and as struts between the two verticals; the bottom members serve as struts only. Thus there is produced a the unsupported height was only 3 ft. Rods placed in the hull and deck slabs below and above these bulkheads cause the structure to conform to the requirements of a plate girder. By placing reinforcement on both hull and deck either flange is capable of taking tension; that is, the girder is effective as a plain or as a cantilever beam, so that it can take care of hogging and sagging strains. Actually, the vessel could be supported at its two ends only or by its middle third without overstressing the members.

The slabs in the bottom are 4 in. thick and in the side 3½ in. The reinforcement used is welded wire and deformed bars. In the slab the reinforcement was entirely of mesh, of which two layers were used in order to provide for the negative moment. Rods were used for beam reinforcement. In addition, a number of rods were placed to take care of the strains induced by hogging and sagging action. Much care was used in the choice of concrete materials, and the final choice was a special mixture of limestone screenings and ¾-in. crushed limestone. The virtue of this product is the perfect grading of materials from the fineness of portland cement to the ¾-in. aggregate.

In the design the stresses used were 12,000 lb. per square inch in steel and 800 lb. per square inch in concrete. The stress in concrete was taken as 37½% of an ultimate strength of 3000 lb. Tests made by the



DETAILS OF THE DESIGN OF NAVY OIL BARGES BUILT BY L. L. BROWN COMPANY

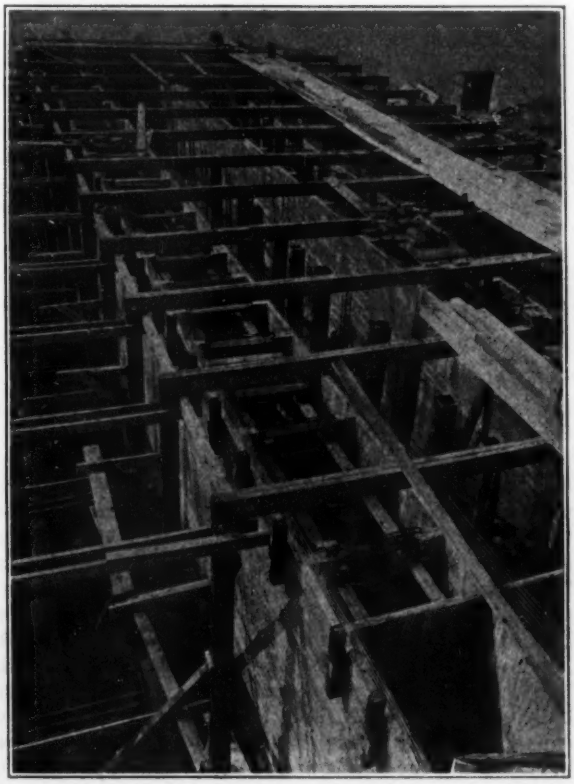
United States Navy showed the concrete to have a strength uniformly greater than the 3000 lb. assumed above. The average of these tests was 4000 lb. per square inch, with a maximum of 5400 lb. per square inch. The test specimens were cylinders 6 in. in diameter by 12 in. long, made by the resident inspector from concrete taken from the mixer during the actual pouring of the barges.

The layout of the yard and installation essential to construction is shown in one of the drawings. The berths are 50 ft. c. to c., and each berth has two ways 25 ft. c. to c. Each way consists of a concrete wall 18 in. thick, extending from the shore line back 150 ft. on a slope of $\frac{3}{4}$ in. to 1 ft., or 1 to 16. On top of the wall was placed an 8 x 16-in. timber secured to the concrete, as the fixed or permanent way on which the traveling shoe found bearing. Each berth also has concrete slabs in the ground between the ways, and on these foundations timber blocking was built up to a height 6 in. above the top of the permanent way timber. On this blocking were placed transversely building ways of 12 x 12-in. timber and of such length that they exceed the width of the barge by 2 or 3 ft. On these building ways the bottom forms were built, the entire structure being supported on the ways until within a week of launching.

After the concreting of the barge has attained sufficient strength, the building ways are removed and blocks substituted. On the day of the launching the 6 x 12-in. shoe was placed on the permanent way, well greased, the space between the shoe and the hull was well packed with timber, and the blocks were removed. With all blocks removed and the boat resting on the shoes, the component of gravity along the way was resisted by anchorage of the 6 x 12-in. shoes at the offshore end. The sawing of the two shoes simultaneously effected the release of the barge at the time desired and insured an equal start on the two ways. The ways were extended into the water sufficiently to satisfy the condition that at all times during the launching the moment of buoyancy about the end of the ways was greater than the moment of the weight of the barge about that point. In other words, the angle which the bottom of the barge made with the horizontal did not increase.

In order to carry on the work economically, a two-level gantry was erected across the upper end of the barges and a concrete tower was provided to deliver concrete to these levels. This gantry connected with platforms down the center of the barge. A concrete water tank was built and water was piped to all parts of the work, so that an ample supply was available for wetting down the concrete. In the actual placing of the concrete the manner of placing was considered of greater importance than the quantity placed. The pouring of a complete barge in one operation was not attempted. Joints were foreseen; their locations were chosen and the bonding of new concrete to old was provided for. For instance, a horizontal joint was made at the level of the intermediate deck. At this point a large area of bonding was obtained, together with a maximum of reinforcement with the condition of no shears, since the slab support is here vertical.

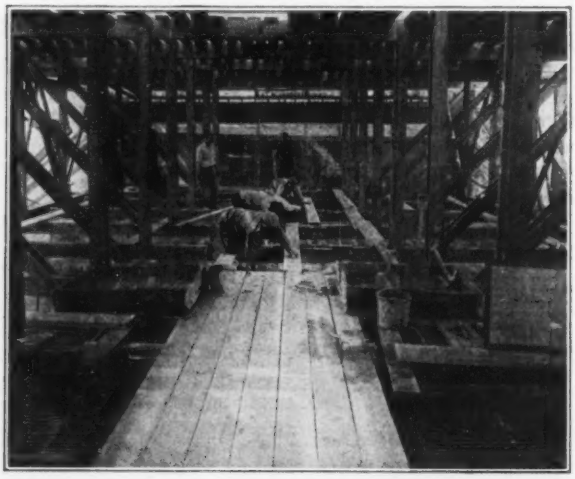
In building the barges the bottom forms were first laid on the ways, extending up both rakes, and on this form were placed the two layers of mesh and the longi-



LOOKING DOWN ON OIL BARGE DURING CONSTRUCTION

tudinal rods. The mesh was placed transversely and was cut in lengths which extended above the joint in the sides of the hull. Posts were then erected and inverted trusses, framed of light lumber, were placed so that the upper chord spanned 40 ft. clear—that is, 2½ ft. each side of the outside skin of the boat. The lower chord was 30 ft. long and was included within the outside forms. This lower chord supported the reinforcement and the working platforms and runways. The chords were spliced, the framing was simple, and the erection by means of a gin-pole was easily effected. The lower chord was placed high enough to clear the intermediate deck by 2 ft. and the lower level of the gantry connected with the platform on the lower chord of the trusses.

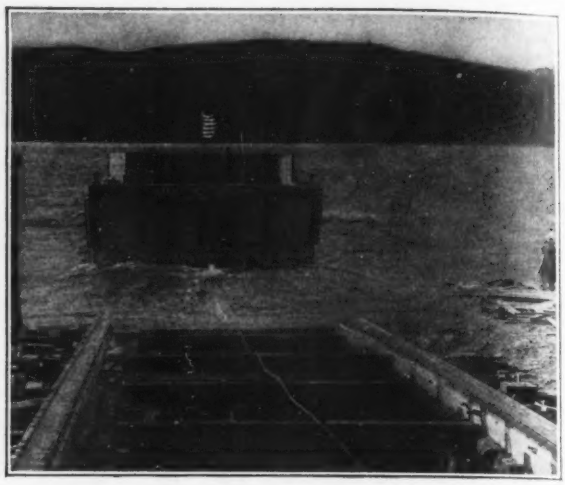
The bottom of the barge was first concreted, the concrete being conveyed to the panels by buggies. Tied to the bottom reinforcement, stubs were placed to extend up into the bulkheads, longitudinal and transverse. The next step was the placing of reinforcement and forms for the longitudinal bulkheads and the intermediate deck. The forms were in 8-ft. lengths and in three parts forming the two sides and the top of the square, or, as it was called on the work, the tunnel. The stubs tied to the bottom reinforcement were hooked into the strands of the reinforcement of the bulkheads, such engagement giving a positive connection of the reinforcement of the



INTERMEDIATE DECK OF NAVY OIL BARGE CONCRETED FROM SUSPENDED RUNWAY

two parts. This scheme of bonding was followed throughout the construction.

The bulkheads and the hull were poured to the level of the intermediate deck, and the intermediate deck was then poured. The webbing and the lower chord of the trusses were then removed, and the platform was shifted to the upper chord. This chord was posted in the center. The forms for the bulkheads above the intermediate deck were then set, the panel forms on the sides on which there were no beams being placed first. Against this the mesh was placed and then the 4-ft. panels forming the slabs and beams were set. These bulkheads and the hull were concreted to the deck level in two lifts. With these forms removed, supports were provided and the panels of the deck forms were placed. In concreting the deck the methods used in pouring were similar to those used in pouring floors.



BARGE LAUNCHED ENDWISE FROM CONCRETE WAYS

Additional reinforcement was provided where the deck fittings were placed, and holes were left in the deck for the fitting bolts. The fittings placed were standard Navy fittings. Under each was placed an oak seating 3 in. thick to protect the concrete deck. A 2-in. oak washer was provided below deck for each of these bolts, and the bolts were grommeted to make them water-tight. A waist for the deck cargo consists of brackets of structural steel bolted to the deck on 8-ft. centers and supporting 5 ft. of 3-in. pine plank. The fenders are 6 x 12-in. oak cut from local timber, bolted to the sides of the vessel by ¾-in. bolts 2 ft. on centers. Inside, a 2-in. plank was framed between the vertical beams to act as a washer for two bolts.

One of the essential features in the construction was the curing of the concrete. Concreting in extremely hot weather was avoided, and at all times the concrete was shaded from the sun for at least two weeks after placing. The surface of the concrete during this time was constantly kept wet, being sprinkled as often as was necessary. After the removal of the forms the exterior skin of the barge was carefully gone over, and all projections were rubbed down by a carborundum brick. The surface of the concrete was then rubbed with a cement brick, directly following a brush of thin mortar. Consideration was given to the painting of this hull with a paint other than a cement product, but the Navy gave instructions that this be omitted, in order to test the water-tightness of the slab. The barges proved to be dry—dusty dry. However, it is probable that an application of some waterproof coating on the skin of barges would be desirable in that it would assist in preventing water from attacking the steel reinforcement of the barge.

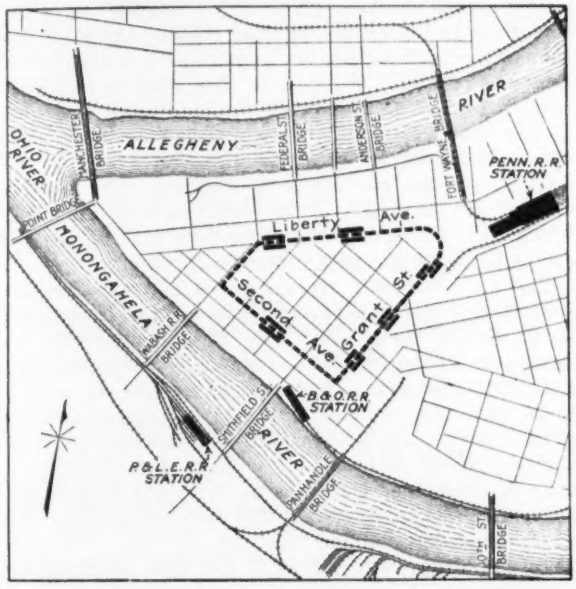
England Has Built Twenty-Two Concrete Barges

Up to Mar. 25 Great Britain had launched 22 concrete barges, according to a statement recently made in the House of Commons. Of these, nine had been completed and five actually delivered. Twenty-two more barges are under construction, as well as six concrete tugs. It is stated that as the Government does not require such vessels now, it is not the intention to build more, because in the opinion of the Admiralty there has not yet been sufficient experience to justify opinion concerning their success.

Street-Car Loop Subway Proposed by Pittsburgh

Six-Million-Dollar Municipal Project, to Relieve Downtown Traffic Congestion, Advocated by City Authorities

ISSUE of city bonds for $6,000,000 to build a street-car subway loop in downtown Pittsburgh has been proposed by the mayor and public works department to the voters of the city. Following several prior studies for transit improvement in the city, a report recommending two rapid-transit lines from the heart of the city to the eastern suburbs was rendered a year ago by E. K. Morse, appointed as city transit commissioner to investigate the situation and work out a solution. This



PROPOSED STREET-CAR LOOP SUBWAY IN PITTSBURGH

recommendation, which contemplated an expenditure of something over $12,000,000 for the two lines, did not meet with the favor of the city officials, however, partly for the reason that it would not relieve the downtown congestion of traffic. On account of the topographical limitations to the development of the Pittsburgh business district, the narrowness of the downtown streets, and the very great density of street-car traffic morning and evening, it has been concluded that relief of the surface-car congestion must be the first line of attack on the transit problem. The present project has been developed from this point of view.

In the accompanying sketch map of the "Point" district of Pittsburgh, taken from a recent pamphlet by N. S. Sprague, chief engineer of the city's department of public works, the proposed loop subway is indicated by a broken line. The route extends through Liberty Ave., Ferry St., Second Ave. and Grant St., passing the Pennsylvania Railroad station at the turn from Grant St. into Liberty Ave. The structure i to be 8400 ft. long and is to be a two-track subway in which all cars will operate in the same direction around the circuit. Passengers will enter and leave by way of six stations, three of them being located on Grant St. (at Fourth Ave., Fifth Ave and Seventh Ave.), two on Liberty Ave. (at Wood St. and at Fifth Ave.), and one on Second Ave. (at Wood St.), the station intervals ranging from 760 to 1860 ft. Cars will enter and leave the subway by way of portals located above high-water level.

It is intended that all surface cars in the city shall loop through the subway except the North Side, West End, and Lincoln Ave. cars, which will extend only to the outer edge of the business district and will turn back by way of surface loops on Liberty Ave. (between Federal and Stanwix Sts.) and around the court house at Grant and Diamond Streets.

Referring to present traffic conditions and the proposed subway service, Mr. Sprague reports that at present 573 cars per hour enter the downtown district during the rush hours. Of these about 60%, or 335 cars per hour, would use the subway loop, the others using the two surface loops mentioned.

No definite plans for operation have been formulated, but the city officials believe that the subway can be leased to the street-railway company for operation. Inasmuch as the use of the subway would probably not increase the revenues of the street-car system very greatly, it is anticipated that part of the cost of the subway will have to be borne by the city. This is regarded as a proper offset against the cost of street widenings and other improvements which would have to be made for relief of street traffic if the subway were not built and the street cars thus were not taken from the street surface.

Development of the loop into the downtown portion of a true rapid-transit system is thought to be quite practicable at a later time. No suggestions have been made for future provision for the surface cars when the loop is thus taken over for rapid-transit service.

Engine Terminals and Roundhouse Cost

AN engine terminal capable of handling 100 locomotives daily will cost about $660,000, at present prices, for construction and equipment, according to a paper on "Modern Tendencies in Roundhouse Design," read before the Western Society of Engineers by E. M. Haas, railway specialist of the Austin Co. This would give annual fixed charges of about $69,300 at 10½% for interest and depreciation, or about $2 per engine per day. About 33% of the total first cost would be represented by the roundhouse and its equipment, the building of reinforced concrete. The cost per roundhouse stall at 1918 prices has ranged from $6000 to $22,000 for the building, with light, heat and plumbing; while for the entire terminal it has ranged from $25,000 to $50,000 per stall. The higher costs imply permanent construction and ample labor-saving facilities. The distribution of cost of such a terminal is shown in the accompanying table.

Fire-resisting construction is highly desirable, for,

COST OF ENGINE TERMINAL TO HANDLE 100 LOCOMOTIVES DAILY

24-stall roundhouse	$220,000
Grading, drainage and tracks	70,000
Two inspection pits and service building	16,000
Coaling and sand station, water-supply	74,000
Two water-type ashpits with a gantry crane	36,000
100-ft. turntable and pit	20,000
Oil house and equipment	10,000
Machine shop and power house	64,000
Boiler-washing plant, 10-ton crane, electric hoist for engines, shop and power house equipment	120,000
Miscellaneous	30,000
	$660,000

although roundhouse fires are not frequent, they may cause great loss to expensive locomotives, besides putting engines out of commission. This may be the case even if only the roof is of wood. Timber frame and roof with brick walls has been a very general type, but involves high cost for depreciation and maintenance. Both steel and concrete construction were noted by Mr. Haas, but he favored the latter, and also preferred monolithic concrete construction to the unit system. He referred to the desirability of long span between the posts, in order to avoid interference with the work on the engines. For this reason a design used by the New York Cenetral R.R. has a 64-ft. truss span over the main space. Incidentally, these trusses were originally made of heavy timbers, but they are now built up of planks, in order to cheapen the construction.

Overhead cranes have been applied in a number of roundhouses and an investigation made on the Pennsylvania R. R. showed that the maximum load to be handled was about 8½ tons, so that a 10-ton crane would be adequate for this service. In Mr. Haas' opinion there is a tendency to substitute the engine hoist for the drop pit for handling wheels and axles, owing to the greater liability of danger in jacking up the engines on the pits, due to weight of modern engines and the use of inexperienced labor. For heating, the hot-blast system is considered preferable, as it costs little more than the direct system and has the advantage of providing forced ventilation.

Daily Code Letter Shows Status of All Highway Work

Texas State Highway Department Condenses All Daily Progress Reports Into One Page by Means of Alphabetical Symbols

BY JULIAN MONTGOMERY
Division Engineer, Texas State Highway Department

USING alphabetical symbols, the Texas State Highway Department, which has 189 state-aid projects and 190 Federal-aid projects, has found it possible to make on one sheet of letter paper a combined daily progress report of the status of all jobs. The key for the code letter, which is sent to each recipient of the report, makes it possible to tell at once the condition of each job in the state, while the job number and county indices give a complete description of the project. These reports have been found very useful in conveying accurate information to commissioners and engineers who are constantly being questioned as to the status of the various jobs.

Due to the recent war, most state-aid and Federal-aid projects have been inactive. The majority of the counties in which they are located have not finally completed their applications for aid, one of the main reasons being that they had no available funds at the time of making application. In order to complete their applications they must show the source from which the county's share of the cost of construction is to come —usually bond issues.

Whenever aid is allotted to a county on a state highway, this allotment is given a job number for filing reference, and when the job has reached the stage for the execution of the project agreement it is then given a project number. Work other than road construction, such as the preparation of county road maps (specified by law to be done by the highway department in certain instances), involving the expenditure of money by the department, also receives a job number. The projects are in various stages of progress, ranging from 195 which have not finally completed their applications for aid, to 81 which are now under construction.

The state highway engineer, the highway commissioners, and the division engineers, located in different parts of the state, every day receive numerous inquiries concerning the present status of these state- and Federal-aid projects. In order to be able to answer these numerous inquiries, and to have the present status of each job for available information, the state highway engineer found it necessary to have a comprehensive daily progress report of all jobs. To serve its intended purpose, it was necessary for this daily report to be very brief, easily digested and thorough.

To the writer was entrusted the task of designing such a report. It is easily seen that an ordinary written report covering about 400 jobs, if intelligently prepared, would cover 10 to 12 pages. To issue such a report daily would entail a great deal of printing and consume a large quantity of paper. It was found that a status key combined with a job number key enabled the daily status of every job to be given on one sheet of paper.

CODE LETTER, JOB AND COUNTY INDEXES AND CODE KEY USED BY TEXAS STATE HIGHWAY DEPARTMENT

Daily Report on Jobs, March 8, 1919

1	RARHLRRALQ	RRQRRVLRYW	RRMNYNRYRY	BARAAAAEER	AHHYYRYBBR	50
51	AYYHVRNLHR	PGARALLAFY	YAABAGARLY	AYAARBIAEB	YNFAAABBBA	100
101	NAHEBAARAA	ARBAAAMAAR	LAAAAYYAAR	BAARBAAAAA	AHMBARARLO	150
151	QKGAAGARNB	BAAARRABAA	AHRABAAAAA	AAAARARAAA	AAAAAAAHBG	200
201	AGQAAABPZR	RNBAACAABA	BAZZBAAHWO	ZAACRNAAAA	AAAAZZZZAA	250
251	NAAAAALNHZ	YBAAABAADR	ABANANAAAA	ZAAAAAAARA	AARNRAAAAA	300
301	AAAARARAAA	AAAAEHAARG	BAAAACACAB	AAAAAAAAAM	BRNCABAAGA	350
351	AAAAAAEDAA	NAAAAAYAAA	AAAAAAAAAA	BBAAAAAAA		400

"Present-Status" Key

A	Application incomplete
B	Application complete
C	Plans received; application incomplete
D	Plans received; application complete
E	Plans returned for correction
F	Revised plans received
G	Plans approved
H	Federal-aid plans forwarded
I	Federal-aid plans returned for revision
J	Revised Federal-aid plans forwarded
K	Federal-aid plans approved
L	Letting advertised
M	Bids rejected
N	Contract awarded
O	Contract executed
P	State Project Agreement executed
Q	Federal Project Agreement executed
R	Work started
S	Work suspended
T	Work renewed
U	Work complete
V	Work accepted.
W	Final estimate paid
X	Final reimbursement received by Federal Government
Y	Project suspended or dead
Z	Spacer or filler or County Road Map

Job Number Index (Sample)

Job No.	County	Estimated Cost	State Aid	Federal Aid
150	Travis	$100,436.00	$25,109.00	.....
151	Guadalupe	12,316.25	.....	$5,000.00
152	Camp	65,644.52	.....	17,454.00

County Index (Sample)

County	Local Name of Road	Job No.	Highway No.	—Project No.— State Aid	Federal Aid
Taylor	Texarkana-El Paso	297	1	61	..
Titus	Texarkana-El Paso	54	1	13	26
Travis	Austin-Lockhart	150	29	33	..

A reproduction of the code portion of one of these sheets, together with the key, is given in the table. The code in this case covered only about one-third of a sheet and the remainder was used for a summary of the various information and an announcement of coming lettings and jobs under construction.

It will be noticed that the code letters in the daily report are arranged in groups of 10. This is for convenience in locating the job numbers. Beginning in the upper left-hand corner, the first capital letter denotes the present status of Job No. 1, the second capital letter that of Job No. 2, etc. Fifty jobs are on each line, arranged in groups of ten. To expedite the location of job numbers on the report, the numbers of the first and last job on each line are placed at the beginning and end.

The "present-status" key is self-explanatory. Each capital letter represents a step in the process of the completion of the project, from the time when aid is granted to the acceptance of the completed work and payment of the final estimate. Some of the job numbers refer to other things besides state- and Federal-aid projects, such as the preparation of country road maps. The letter "Z" is supplied for such jobs.

Each person to whom the daily report is sent is supplied with a job number index showing the job number, county, estimated cost, state aid and Federal aid. In addition, an alphabetical index by counties is furnished showing county, local name of road, job number, highway number, state project number and Federal project number. Samples of these indexes are also given in the table.

Example

It is seen that the last letter in the third line of the daily report is "O." This is the 150th letter and therefore gives the present status of Job 150. Referring to the "present-status" key, the letter "O" shows that the project has reached the stage where the contract for Job No. 150 has been let and executed between the contractor and the department. Knowing that the project has reached this stage, it is known also that all the stages preliminary to this have been completed.

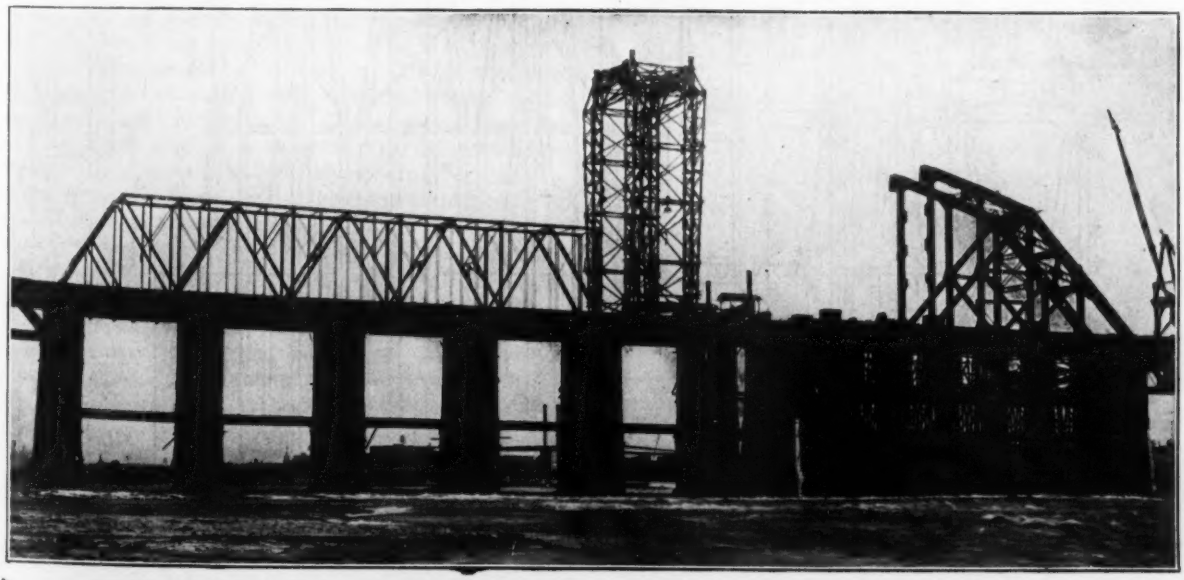
Referring to the job number and county indexes, it is noticed that Job No. 150 is a state-aid project, No. 33, on the Austin-Lockhart section of state highway number 29, Travis County, and that $25,109, state aid, has been allotted to this road.

This daily report is printed by multigraph which is kept set all the time. Only such daily changes are made in the capital letters as are dictated by the changes in the present-day status of each job.

Maintaining Traffic During Erection of Louisville Bridge

Floods and Washouts Caused by Swift Current of Ohio River Force Revision of Methods—Timber Towers Support Longitudinal Steel Girders

THE erection of the new double-track riveted-truss spans outside of the historic Fink trusses of the Louisville bridge practically without interruption of traffic was completed last year in spite of many difficulties caused by the swift current of the Ohio River and unusual flood conditions which at one time resulted in the loss of some steel lower chords and floor material by the washing out of the falsework. By bunching the trains to pass over the bridge at the noon hour or about 4 p. m., and diverting some trains to other bridges at the critical stages in the work, operation was maintained throughout the two years from June, 1916, to October, 1918, during which time about one mile of steel superstructure was erected, including the long 644-ft. riveted span and a 260-ft. lift span. The old masonry piers were built by removing the upper courses and capping with steel grillages surrounded by concrete. The principal design features of this bridge were de-



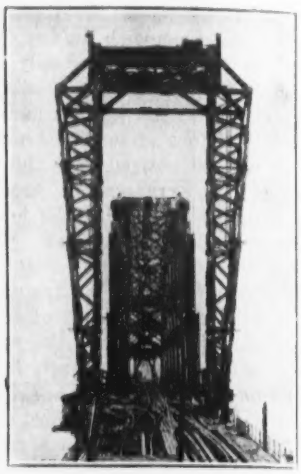
GANTRY TRAVELER DISMANTLING OLD 400-FOOT SPAN AND ERECTING NEW 644-FOOT TRUSSES

scribed in *Engineering News-Record* of May 22, 1919, p. 1007.

Erection of the 644-ft. span was carried out by the use of timber bents built in groups of four and supporting longitudinal steel girders for the tracks of a gantry traveler. Many difficulties had to be overcome in placing these bents on the rough rock bottom of the river. In general, the principle adopted to avoid flood danger was the use of longitudinal steel girders on timber towers spaced to conform to the lengths of the available girders. This resulted in greater clear waterway for the swift current, which averaged about 10 miles per hour, and a less number of bents to be set on the river bottom.

Erection Progress—Erection work started in June, 1916, on the deck spans at the north end, working from the abutment to the Indiana channel span. By Oct. 1, 823 ft. had been erected, consisting of three 180-ft. deck spans, one 150-ft. deck span, and two small girder spans. Between Sept. 1 and Sept. 15 of the same year, five 245-ft. deck spans, connecting the two through-truss spans, were completed. The next year the 370-ft. through span was constructed between Apr. 25 and July 10, followed by the remaining nine deck trusses on the Louisville side, which were completed by Jan. 20, 1918. The lift span, with its approach girder spans, was erected in the spring of 1918. Work began on the 644-ft. through span on Apr. 20, 1918, and it was swung on Oct. 15, 1918, about six months later.

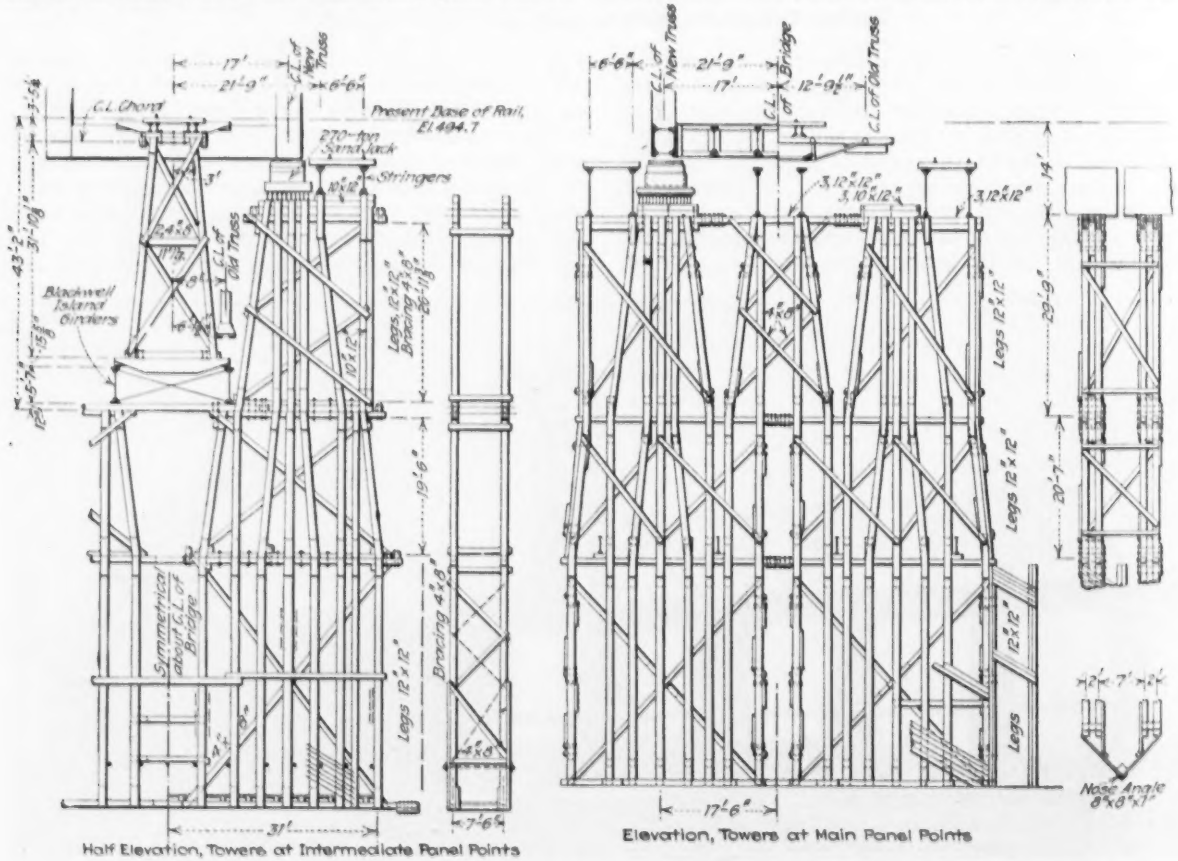
Deck Span Erection—A regular sequence in the erection of the series of 245-ft. deck truss spans was followed. In each case the first operation was the construction of the double-bent timber towers. These were placed on concrete pedestals anchored to rock by 1¼-in. gaspipe set in cement grout, similar concrete foundations also being used for the pedestals of the 370-ft. Kentucky channel span.



GANTRY ERECTION OF 644-FOOT SPAN

The timber towers, which supported steel girders at a level just below the lower chords of the old trusses, were spaced according to the length of the girders available—in the case of the deck spans these girders were 70 ft. long and were obtained from the contractor. They were placed by a derrick car from the old Fink-truss spans. Timber pony bents were then erected on these girders, one on each side of the panel points of the old truss, blocking up under the old stringers to support the floor. Except for the first group of spans erected, these pony bents, as shown in one of the drawings, were supported by floor-beams removed from the old trusses.

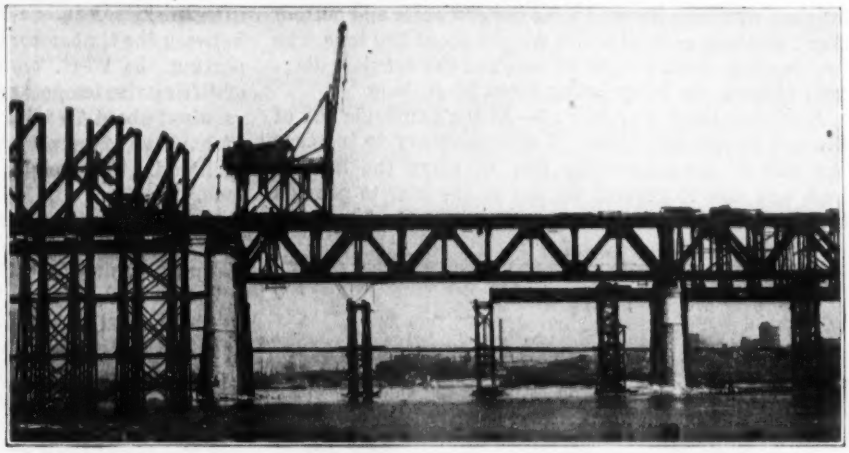
As soon as this falsework had been constructed and



TYPICAL FALSEWORK BENTS FOR ERECTION OF 644-FOOT SPAN—OUTSIDE TRACKS FOR GANTRY AND MATERIAL CARS

the floor supported in two adjacent spans, the old intermediate masonry pier was cut down by carefully removing the stones to a level far enough below the desired pedestal support of the new deck girders to allow the steel grillages to be placed on top of the pier, and concreted.

Regular Sequence Followed—Three spans at a time were thus carried on falsework, many of the bents of which were used over and over in successive spans, and a regular procedure was adopted, as follows: In the first span, the old wrought-iron members of the trusses were being burned through by acetylene torches and the cast-iron chord splice bolts burnt out, allowing the removal of the old trusses; in the next span the steel of the new trusses was in process of erection by a through mule traveler built up of steel and timber, as seen in one of the photographs; in the third span the new truss members were being riveted, and the falsework bents then removed for use in the next span.



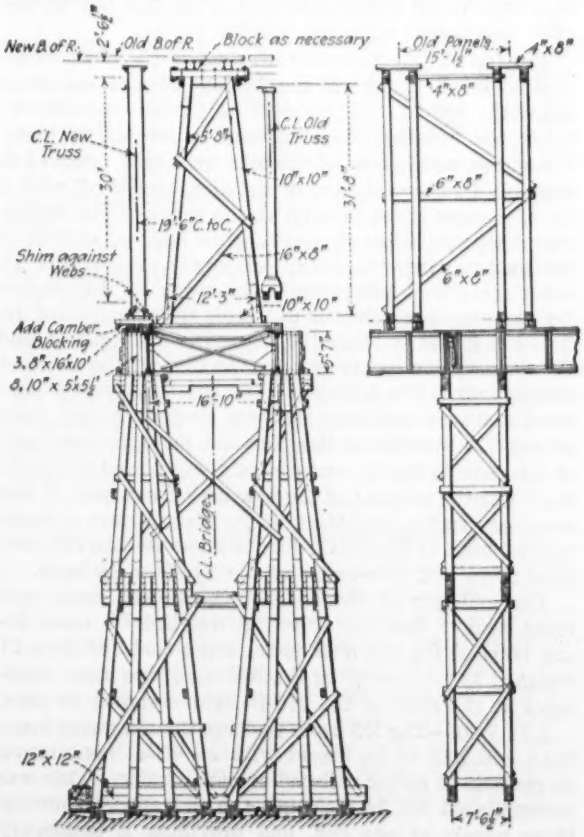
THROUGH MULE TRAVELER AND DERRICK CAR WHICH ERECTED DECK TRUSS SPANS OF LOUISVILLE BRIDGE

Since the old trusses were so light, it was necessary to use care not to overload them in the erection operations carried out by derrick cars on the old tracks. In changing floor, two or three panel units were handled by these cars, the old stringer connections being cut through at the floor-beams. Special blocking on the pony bents supported the old stringers in adjacent panels.

Under the lift span, where the rock bottom of the canal is covered by several feet of soft mud, the bottom story of the falsework was set one leg at a time between guide timbers, and driven to bearing on rock by two or three blows of a light pile-hammer. This method was also used under the 644-ft. span, although the rock bottom was clear of mud. However, the depth of water, 10 or 12 ft., and the velocity of the current, about 10 miles per hour, would have made it very difficult to place concrete footings on the river bottom. Under the large span the legs were shod with cast-steel shoes, but no shoes were used in the canal. Before this scheme was adopted it was planned to use rock-filled cribs under the long span, but the attempt was abandoned.

Erecting 644-Foot Span—The general procedure in the erection of the 644-ft. span which replaced the old 400-ft. through span and one of the 245-ft. deck spans and involved, therefore, the removal of the intermediate pier, was as follows: A creeper traveler on the top chord of the through span was used in placing the timber bents below that span, and derrick cars placed the bents under the deck span. The spacing of these timber bents in the longer span was equal to the double-panel length of the big truss, while in the shorter span bents were placed under each panel point. Longitudinal steel girders were placed on top of these bents just below the lower chords of the main span in the longer opening, and below the lower chords of the deck span in the shorter opening. As illustrated in the cross-section here reproduced, these falsework bents supported the floor of the old bridge, two outside tracks upon which the material was transported and also the large gantry traveler which spanned the new trusses, the latter being spaced 34 ft. center to center. After supporting the old floor system, the old trusses were removed.

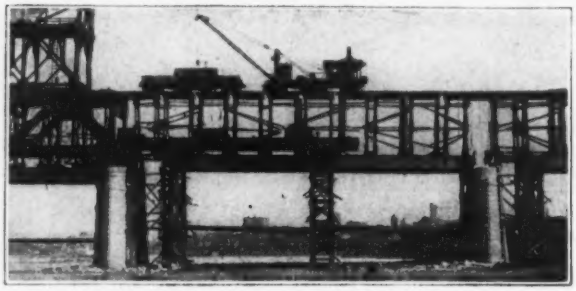
The gantry traveler which erected the heavy truss members was 145 ft. high overall, 124 ft. high inside and 46 ft. wide. This gantry traveler weighed 280 tons, with 100 tons extra weight for two engines. The lower chords of the trusses were placed first, then the floor system was changed, and the web members erected in order, beginning at the fixed end of the span. The



TYPICAL FALSEWORK AND PONY BENTS—DECK SPAN

heaviest members handled were the end posts and bottom chord sections, each of which weighs about 130 tons. The heaviest top chord weighs 95 tons and the heaviest diagonal 42 tons, the latter being about 95 ft. long.

Replacing the Top of Pier 19—At the Louisville end of the new long-channel span, it was necessary to increase the size of the supporting pier to carry the heavier load, and also to rebuild the top of the pier to provide a recess for the new deck truss span on the Louisville



TRACK CARRIED BY PONY BENTS ON GIRDERS SUPPORTED BY TIMBER TOWERS

side, and at the same time secure adequate support for the heavy span. Futhermore, as the new span was erected before the adjacent 245-ft. old span had been supported by falsework, it was necessary to provide a special braced cross-girder to allow removal of the top of the pier and support the old span. The pier was enlarged by placing about 3 ft. of masonry around the old masonry, using stones removed from the top of the other piers, well anchored into the piers.

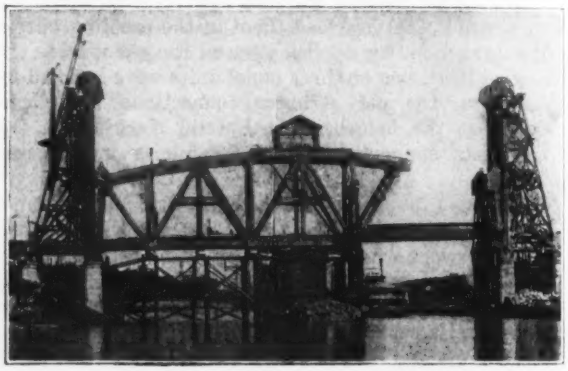
The top of this pier was first cut down to an elevation about 6 ft. below the bottom of the old truss pedestals, except that supporting stones immediately below the bearings were allowed to remain in place. The stones on the nose of the pier were then removed to about 39 ft. below the top of the pier, leveled off with 1 in. of cement grout to support the shoes of the temporary bent consisting of steel columns built up outside of the pier to carry the heavy temporary cross-girder already mentioned. Between trains, using old floor-beams for jacking beams, the end of the old span was jacked up, the stone pedestals below the bearings were removed, and the cross-girder was swung over to support the old span temporarily. The pier was then cut down to its final level, and steel grillages and new concrete coping were placed. In rebuilding the pier, old masonry was used as the outside facing, and concrete was placed for backing. For the support of the new deck truss span, it was necessary in the rebuilding of the pier to leave a recess carried back to the center line to allow for the end vertical posts and floor-beam of the 245-ft. deck span.

The grillages at the ends of the 644-ft. span were quite heavy; that for Pier 19 weighed 57 tons, being notched for the deck span, while that for Pier 21 weighed 73 tons, covering the full top of the pier. Grillages at the ends of the 370-ft. span weighed 50 tons.

Lift Span—The lift span replaces the old swing truss span and had to be placed with as little interruption as possible to either railroad or canal traffic. This was accomplished by first closing the old span, removing three panels at one end, and providing a temporary lift girder span in one channel. An 83-ft. clear opening between the timber bents was provided, these bents supporting the 90-ft. temporary girders. The operation of lifting the temporary girders to allow a boat to pass required about 20 min. and was carried out by the use of hand winches with wire lines to gallows frames at each end. The weight of this temporary span was 82 tons.

The steel-frame towers for the permanent lift span were erected and the old span was removed over both channels. Using a derrick car and locomotive crane the new floor and truss members were placed on falsework in the channel on the Louisville side of the canal. The floor and bottom chord were extended one panel, and the top chord two panels, north of the center of the span. This permitted the erection of the machinery house, situated on the top chord at the middle of the bridge, and the installation of practically all machinery, without the canal being closed. At the same time, the two north end posts were erected and the concrete counterweights poured and connected to the lift span. At this stage the canal traffic was of course closed while trusses were erected. Railroad traffic also had to be interrupted about eight hours while the temporary lift span was removed and the permanent floor placed. This operation was carried out by two derrick cars.

The plans for erection were developed under the general supervision of J. F. Ritter, superintendent of erection of the Bethlehem Steel Bridge Corporation, Steelton, Penn., with O. J. Marsten as assistant engineer in charge of drafting the plans, and J. L. Poffenburg as engineer in the field. J. J. Kelley was general foreman on the work. The plans for the erection were approved by J. C. Bland, engineer of bridges, Pennsylvania Lines West of Pittsburgh.



TEMPORARY LIFT GIRDER IN USE—HALF OF LIFT SPAN ON FALSEWORK

Power Flushers Economical at Ottawa, Ontario

Two power flushers mounted on motor trucks have satisfactorily flushed 18 miles of streets of various widths each day at Ottawa, Ont., according to the annual report of Andrew F. Macallum, commisioner of public works. The cost per mile averaged $1.72. These trucks operated for 106 days at a cost of $4650. They replaced 20 of the old horse-drawn sprinkling wagons at an operation cost of $16,800. Thus a direct saving of $12,150 is shown.

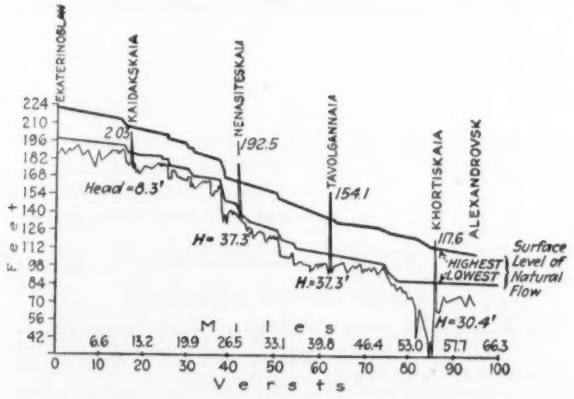
Russian Water-Power Possibilities at Dnieper River Rapids

Hydraulic and Canalization Project Interrupted by War — Four Dams and Power Plants Would Give About 600,000 Horsepower Nominal

By V. V. Tchikoff
Consulting Civil Engineer, Berkeley, Calif.

WATER power is an important item in the vast natural resources of Russia. It will undoubtedly play a great part in the development of the country, because coal and other fuels are not distributed uniformly over Russia, and there is a lack of fuel in some very important industrial regions. The total potential water power of European Russia alone is estimated at 20,000,000 hp. or more. This is mostly concentrated in the border regions of Russia. The Caucasus has about 10,000,000 hp., and there are about 2,000,000 hp. in the north lake region. All the hydro-electric stations of European Russia have only some 250,000 hp., and most of them are small.

The rapids of the Dnieper River present one of the more interesting possibilities for early utilization. They are located between Ekaterinoslav and Alexandrovsk, within the navigable portion of the Dnieper River. They constitute one of the greatest obstacles to navigation on the canal system connecting the Baltic and the Black Seas. Beginning at Riga and ending at Kherson, this waterway will have a total length of about 1600 miles, utilizing the Rivers West Dvina and Dnieper.



PROFILE OF DNIEPER RIVER RAPIDS POWER SITES

The problem of utilizing the Dnieper River rapids has been worked out by many Russian and foreign engineers. The project of the Ministry of Way of Communication, in 1914, provided for the construction of four dams as follows (see profile): Kaidakskaia, with a fall of 8.3 ft.; Nenasiteskaia, 37.3 ft.; Tavolgannaia, 37.3 ft.; and Khortiskaia, 30.4 ft. The peculiarity of this project is the impounding of the night flow for use during the working hours of the day. Solid gravity dams were designed to be built on the granite foundation, and were to be provided with Thomas and Stoney gates. A canal with locks for boats of 7-ft. draft was proposed, with possibilities for 14-ft. draft.

The project was divided into two phases. The first phase was based upon the 37-year midsummer minimum discharge of 11,000 sec.-ft., corresponding to a turbine capacity of 238,600 hp. nominal, with a maximum of 316,800 hp. during the flood months of spring. The minimum discharge for a 15-day period is 15,100 second-feet.

For the second phase of the project there would be utilized about 22,000 sec.-ft., corresponding to a turbine capacity of 350,000 hp. nominal, and 465,000 maximum and a total of 588,600 hp. nominal. For this there would be necessary auxiliary steam plants of half the turbine capacity, working 90 days per year. The maximum capacity of the turbines was assumed as 1.33 times the nominal capacity. The construction cost of the dams, locks, etc., was estimated at about $25,000,000, and of the turbines, generators, etc., $16,500,000 for the first and $21,000,000 for the second phase, including the auxiliary steam plants, but not the transmission lines to Ekaterinoslav and Alexandrovsk, which are counted at $4,400,000.

For computation of the operation and maintenance costs per kilowatt, a working time of 3000 hours per year was assumed, and interest at 8% on construction capital. The resulting charges are shown in the accompanying table.

In computing the profit of all the stations for the first phase there was used an average operation and maintenance charge of 1.8 kopecks (0.9c.) per kilowatt-hour, well under the cost of power at which the steam plant can successfully compete. On this basis the profit for the first phase is estimated at $1,480,000, and for the second phase $1,700,000.

ESTIMATED CAPACITY AND COST OF DNIEPER RIVER WATER POWER PLANTS AND OPERATION AND MAINTENANCE COST PER KILOWATT-YEAR AND KILOWATT-HOUR

Name of Plant	Phases	Capacities of Turbines Hp. Nominal	Cost of Plants in Rubles, 1 Ruble = $0.515	Operation and Maintenance Cost Per Kilowatt-Year, Dollars	Operation and Maintenance Cost Per Kilowatt-Hour, Cents
Nenasiteskaia	First	98,000	10,458,000	13.4	0.45
	Second	140,000	13,187,000	12.1	0.40
Tavolgannaia	First	98,000	11,404,000	14.4	0.48
	Second	140,000	14,142,000	12.8	0.43
Khortiskaia	First	30,000	5,869,000	24.2	0.80
	Second	50,000	7,322,000	18.5	0.62
Kaidakskaia	First	12,600	4,087,000	38.2	1.27
	Second	20,000			

A syndicate of French and Russian capitalists was ready to carry out the whole scheme of the Baltic-Black Seas waterway, but the old Russian Government was not willing to grant the concession and the Russian Duma was about to make an appropriation for the construction of the project when the great European war broke out.

Vandyke, Photostat and Blueprinting Costs

Production costs of vandykes, photostats and blueprints by the engineering division of the United States Ordnance Department, which during September, 1918, made 370,614, show a large reduction below commercial practice, according to the *American Machinist*. While the cost of vandykes and photostats varies with their size, an approximate cost per square foot can be given on vandykes 18 x 24 in., which cost 11½c. each and photostats 14 x 18 in., which cost 7½c. each. Upon this basis the costs per square foot were, vandykes 3.8c., photostats 4.3c. and blueprints 2 cents.

Excessive Storms Observed by the United States Weather Bureau

BY CHARLES W. SHERMAN
Of Metcalf & Eddy, Consulting Engineers, Boston, Mass.

THE accompanying table shows the rates of precipitation of the most noteworthy storms which have been observed at Weather Bureau stations during 1901 to 1918, inclusive, as reported in the annual reports of the Chief of the Weather Bureau and in the *Monthly Weather Review*.

The data presented show the most intense storms anywhere in the United States at Weather Bureau stations,

Locality	Date	Maximum Average Rate in Inches per Hour for Duration in Minutes															
	1901	5	10	15	20	25	30	35	40	45	50	60	80	100	120	150	180
Galveston, Tex.	Oct. 7-8	5.52					4.12					3.13	2.74	2.58	2.40	2.41	2.40
Jacksonville, Fla.	June 14	7.20	6.30	5.68	4.77	4.18	4.00	4.15	3.94	3.73	3.55	3.11					
Topeka, Kan.	Sept. 13	5.76	3.96	4.08	3.60	3.84	3.56	3.67	3.48	3.16	3.04	2.81	2.19				
	1902																
	1903																
Baltimore, Md.	July 12	8.88	8.34	7.60	6.69	6.05	5.38	4.91									
New Orleans, La.	Mar. 14	4.20										2.75		2.43	2.35	2.35	2.12
Pensacola, Fla.	Nov. 2	6.12	5.28	5.12	4.89	4.35	4.08					3.15	3.20	2.95			
	1904																
Galveston, Tex.	Apr. 22	6.12	5.64	5.52	5.64	5.47	5.34	5.02	4.90	4.72	4.65	4.41	4.18	4.03	3.78	3.42	3.29
Oklahoma, Okla.	June 4											2.66	2.25	1.94			
Taylor, Tex.	May 3	6.60	6.00									2.82	2.45				
	1905																
Cairo, Ill.	June 28											3.15	2.51	2.17			
Montgomery, Ala.	May 30	6.48	6.24	5.64	5.31	5.15	4.98	4.60	4.29	4.13	3.95	3.46					
New York, N. Y.	July 10	8.16	7.20	6.52	5.64	4.78	4.16	3.62									
Shreveport, La.	July 23											2.99	2.63	2.60	2.60	2.43	2.16
Taylor, Tex.	Apr. 29	10.80	10.80	9.20	8.25	6.80	5.78										
	1906																
Anniston, Ala.	Sept. 5	7.80	7.44	7.24	7.08	6.43	5.94	5.58	5.15	4.67	4.27	3.60					
Baltimore, Md.	Oct. 20	13.20	7.26	5.84	4.68	4.03	3.56	3.15	2.91	2.76	2.79	2.61	2.08	1.73			
Kansas City, Mo.	Aug. 23	6.84	6.72	6.60	6.45	6.35	6.14	5.91	5.69	5.46	5.19	4.74	4.09	3.44			
Madison, Wis.	Aug. 8	6.60	6.48	5.48	4.83	4.51	4.18	3.92	3.96	3.98	3.83	3.61	3.40	2.90			
Meridian, Miss.	Aug. 13	6.72	6.30	6.08	5.70	5.15	4.72	4.39	4.10	3.85	3.90	3.63	2.81				
Pensacola, Fla.	Sept. 29	5.88	5.22	5.08	4.95	4.68	4.40	4.19	4.10	4.00	3.90	3.72	3.24	3.13	3.00	2.61	2.48	for 2 hr. 45 min.
Taylor, Tex.	June 25	5.28	5.16	4.64	4.26	3.96	3.86	3.93	3.95	3.85	3.78	3.40	2.85	2.42			
	1907																
Baltimore, Md.	July 18	6.48	5.94	5.72	5.19	4.87	4.40	4.09	3.92	3.62							
Concord, N. H.	July 7	6.60	6.36	6.20	5.64	5.23	4.78	4.46	4.04								
Jacksonville, Fla.	Aug. 4	7.92	6.72	6.04	5.49	4.75	4.10										
Lynchburg, Va.	Sept. 3								3.82	3.91	3.78	3.49					
	1908																
Abilene, Tex.	May 22								3.62	3.41	3.12	2.70	2.38	2.50	2.21		
Jupiter, Fla.	Oct. 27-28	6.48	6.42	6.16	5.46	5.50	5.10	4.90	4.75	4.53	4.39	3.83	3.11	2.65	2.30		
Mobile, Ala.	Apr. 29	7.56	6.90	6.16	5.64	5.23	4.62	4.05									
Richmond, Va.	Aug. 19	8.40	6.78	5.84	5.61	5.45	5.20	4.61	4.13	3.80	3.49						
	1909																
Key West, Fla.	Oct. 9-11								3.59	3.44	3.34	3.20	3.04	2.86	2.62	2.25	2.09	for 2 hr. 55 min.
Pensacola, Fla.	Oct. 20	9.60	9.18	9.16	8.64	8.09	7.30	6.38	5.91	5.35	4.98	4.27	3.37	2.84	2.41		
Vicksburg, Miss.	Apr. 12	8.88	6.60	5.00													
Thomasville, Ga.	June 27	8.52	7.56	7.32	6.81	6.39	5.98	5.37	4.87	4.75	4.53	4.14	3.20				
Thomasville, Ga.	Sept. 17	6.96	6.60	6.16	5.70	5.04	4.68	4.25	3.82	3.45	3.30	2.86	2.24				
	1910																
Davenport, Iowa	July 14	6.48	6.00	5.12													
Galveston, Texas	Oct. 5-6	5.76†	5.76†	5.76†	5.76†	5.69	5.64	5.61	5.58	5.39	5.23	4.01	3.34	3.21	3.14			†Averaged from rainfall 20 min. period.
	1911																
Abilene, Tex.	July 31									4.01	3.77	3.46	2.74				
Augusta, Ga.	June 18	14.89	10.80	8.44	6.78	5.91	5.30	4.75	4.32								
	1912																
Springfield, Ill.	July 6	5.04	4.92	4.80	4.29		4.20					2.75					
	1913																
Galveston, Tex.	Oct. 22	7.80	7.14	6.32	6.06	5.88	5.42	5.60	5.53	5.65	5.55	5.31	4.51	3.91			
	1914																
Raleigh, N. C.	July 14	8.75	8.10	6.84	6.03	5.30	5.14	4.73	4.30	3.92	3.59						
Miami, Fla.	Nov. 8												2.61	2.34	2.30		
Atlanta, Ga.	Aug. 20								4.33	4.04	3.83						
Kansas City, Mo.	Sept. 15	6.60	6.54	6.28	5.55	4.99	4.58	4.17	3.82	3.61	3.48	2.93	2.56	2.11			
Lincoln, Neb.	July 25	7.44	6.95	6.36	5.67	5.37	5.06	4.76	4.35	3.99	3.67						
	1915																
Concordia, Kan.	June 17								4.91	4.38	3.94	3.52	2.72				
Corpus Christi, Tex.	Oct. 4							4.46	4.12	3.77							
Iola, Kan.	Sept. 6								3.94	3.51	3.17	2.73	2.41				
Oswego, N. Y.	July 8	8.88	7.25	5.12													
San Antonio, Tex.	Apr. 18	8.40	6.71	5.44	4.56	4.51	4.20	4.06	3.72	3.45	3.22	2.83	2.33	1.97	2.32	2.14	2.05	for 2 hr. 40 min.
Terre Haute, Ind.	July 7	12.60	7.92	5.52	4.68	4.08	3.60	3.40	3.27	3.17	2.95	2.57	2.20				
Valentine, Neb.	July 6	9.00	8.21	7.48	6.42	5.61	5.04	4.53	4.04	3.72							
	1916																
Macon, Ga.	July 18	7.44									3.46	3.11	2.49				
Miami, Fla.	Aug. 25												2.63	2.50	2.35	2.07	1.92	for 2 hr. 50 min.
Reading, Penn.	July 21												2.69	2.61	2.44		
San Antonio, Tex.	Aug. 29		6.60	5.68													
Wytheville, Ga.	Aug. 22		6.60		5.22	4.73	4.36										
	1917																
Birmingham, Ala.	July 22	7.80															
Jacksonville, Fla.	July 27	8.04	6.96	6.52	5.85	5.44	4.92	4.46	4.06	3.73							
Louisville, Ky.	Aug. 29			5.76													
Mobile, Ala.	July 19	8.76	7.98	5.92													
Savannah, Ga.	Aug. 3											3.40					
Springfield, Ill.	July 23			5.64													
	1918																
Cleveland, Ohio.	Sept. 2														1.47	1.46	1.38	for 4 h. 5 min.
Houston, Tex.	July 2												2.28	2.19	2.00		1.91	for 2 h. 10 min.
Houston, Tex.	Oct. 4		5.82	5.36	4.95		4.16		3.65			3.13	2.61				
La Crosse, Wis.	Aug. 7	7.92															
Meridian, Miss.	June 2			5.52	5.22	4.74	4.36										
New Orleans, La.	Oct. 29											2.68	2.52	2.23			
Red Bluff, Calif.	Sept. 13-14														1.86	1.66	1.59	1.35 for 4 hours
Vicksburg, Miss.	Aug. 19		6.06	5.48	5.19	4.85	4.60	4.39	4.01	3.76	3.53	3.11	2.45				

and have been compiled with the idea of including, as a rule, not more than six storms in any one year. As is well known, the records of excessive storms, as published, are in the form of cumulative amounts for 5-min. intervals from the beginning of the intense precipitation. It has been necessary, therefore, to pick out a large number of storms which appeared on inspection to be most likely to include excessive rates of precipitation, and then compute the rates of precipitation corresponding to the reported amounts. The resulting figures for a large percentage of the storms were then rejected so as to leave only the most important of those in which the rate at some part of the storm was notably excessive. No storm was reported in 1902 which comes within the classification adopted for this tabulation.

With comparatively few exceptions, storms have not been included unless they showed rates of precipitation approximately as large as the following:

For 5 minutes	6.5 in. per hour
For 15 minutes	5 in. per hour
For 30 minutes	4 in. per hour
For 45 minutes	3.50 in. per hour
For 60 minutes	2.75 in. per hour
For 120 minutes	2 in. per hour

These data were worked up in the office of Metcalf & Eddy and are submitted for publication that they may be available for general use.

Faulty Foundation Causes Serious Damage to Armory

Settlement of Piles in Soft Subsoil—Attempts To Arrest Subsidence Fail—Part of Building Taken Down

INSUFFICIENT study of underground conditions resulted in so seriously defective foundation construction in the case of a Minneapolis armory that progressive settlement practically wrecked the building, and the only recourse was to take down part of it. The foundation piles under the building rested in a bed of soft mud instead of going down to a firm bearing stratum, and under the load of the building they went down, at some points as much as 2½ ft. In the course of some years much repairing was done and some attempts were made to remedy the defects. No method of underpinning the structure at reasonable cost was found, however, and finally the armory was condemned; as a temporary expedient, for war service, its heaviest portion was torn down and the drill hall kept in use.

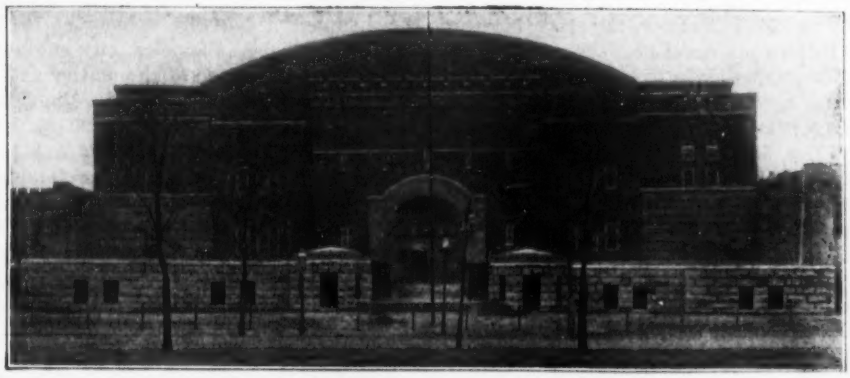


FIG. 2. ARMORY AS RECONSTRUCTED; BASE OF OLD FRONT WALL IN FOREGROUND SHOWS EXTENT OF SETTLEMENT AT RIGHT END

The original structure (Fig. 1) was erected in 1905; its main part is sketched in the plan, Fig. 3. At the east end (left-hand of the view, Fig. 1) there was a rifle range about 20 ft. wide, while at the west end there was a driveway which was later replaced by a riding hall (at right in Fig. 2). The rear portion consisted of a drill hall, 120 x 174 ft., with a reinforced-concrete floor supported on concrete columns, and a steel arch-truss roof. The front part of the building was three stories high, and the floors were of reinforced concrete. The third floor, forming a 70 x 109-ft. dance hall, was roofed by 70-ft. steel arch trusses extending from the front wall to the forward truss of the drill hall. In 1912 a one-story riding hall, having a frontage of 163 feet and extending the full depth of the old building, was built on the west side of the armory. All contracts were let and the structure was supervised by the Board of Armory Commissioners, while the city building-inspection department had no connection with it.

Although the location was formerly swampy ground, and subsequent exploration showed that soft ground below a surface fill extended to a depth of over 40 ft., there seems to have been little or no study of foundation conditions before construction. Piling was provided, but it turned out to be entirely inadequate. Some years previously, in connection with the development of the surrounding high ground as a residence district, a fill of sand and gravel had been deposited over the soft ground, and this superficial condition may have misled the designers of the building. The original piles were 30 to 40 ft. long, as nearly as could be ascertained subsequently. One member of the piledriver crew is reported as saying that some of the piles went down

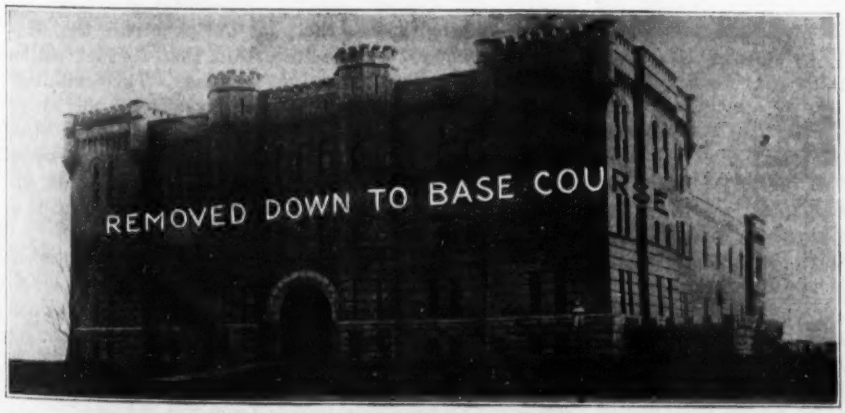


FIG. 1. THE ORIGINAL ARMORY; CONTINUED SETTLEMENT LED TO TAKING DOWN ENTIRE FRONT SECTION

12 to 24 in. under the last blow of the hammer.

Settlement developed even during construction. An attempt was made to level the floors by pouring on concrete, as noted in an account of the wrecking operations printed in *Engineering News-Record* of April 3, 1919, p. 687. Subsequent settlement was of such character that in 1913 the west wall of the main three-story building was condemned, torn down and rebuilt. An attempt to raise the building by jacks, to allow of constructing proper foundations, was made in the winter of 1916-17 by a house-moving company, but the jacks merely pressed their supports into the ground. The plan is reported as having been decided upon by the armory commissioners, without engineering advice. This work was abandoned, the blocking and jacks being left in place, as it was considered dangerous to remove them.

As long as the building continued in use it was necessary to screw up the interior jacks at intervals, in order to keep the floors level. After the building was closed by order of the building inspector, this work was not necessary, which tends to show that occupancy caused the local settlement.

The same contractor undertook to locate firm ground by sinking a well or open caisson about 8 ft. square, but at a depth of about 42 ft. the water rushed in to such an extent that this work was abandoned. Early in 1917 the city building inspector condemned the building as unsafe for occupancy, and it was closed.

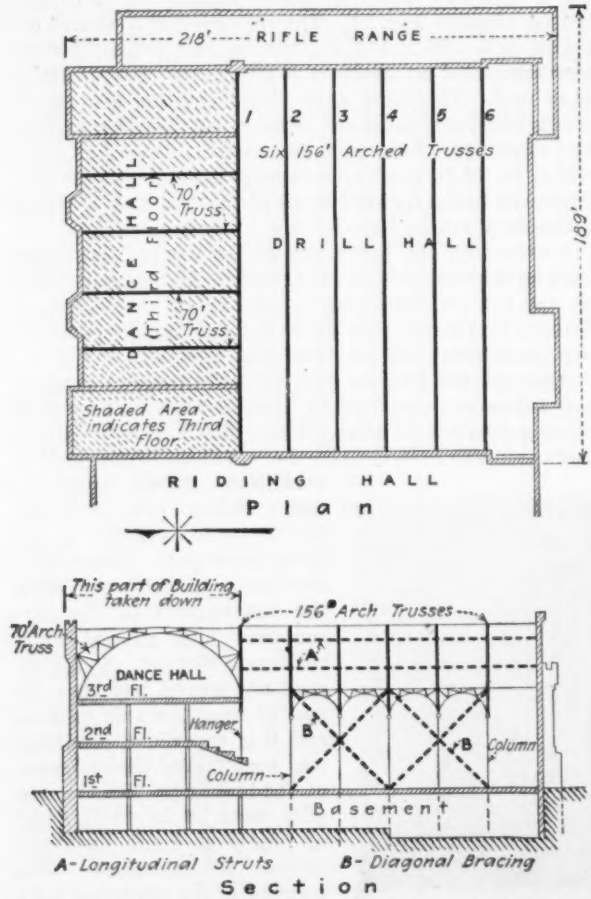


FIG. 3. ARMORY DAMAGED AND PARTLY TORN DOWN AS RESULT OF FOUNDATION FAILURE

In the summer of 1917, the city council requested F. W. Cappelen, city engineer, to make a thorough investigation of the matter and report to the Board of Armory Commissioners. Mr. Cappelen put down eight test holes from 70 ft. to 90 ft. in depth around the outside of the building, and one test hole inside of the building very close to the foundation for the west end of the main truss which carries a part of the roof as well as the third floor of the main building. He found that generally there was from 15 ft. to 20 ft. of surface fill, below which was a stratum of mud varying in thickness from a few inches to 41 ft. Underlying the mud were sand and gravel strata. Ground-water was about 1½ ft. below the footings, or below the cut-off level of the piles.

As to settlement, he found this to be 37½ in. at the northwest corner, 3 in. at the southwest, ½ in. at the northeast and zero at the southeast corner. The west ends of the roof trusses of the drill hall had settled 5 in. for the south truss and 9, 12½, 18, 21½ and 26 in. for the others, in succession. Their east ends had settled from zero to 2 in. Mr. Cappelen's report stated the conditions as follows: "Most of the inside columns and practically all the walls have settled. In fact, the whole building is wrecked, and the only reason that it does not fall down is that the concrete floors are reinforced and tie the whole thing together like a box."

Additional piles would have had to be 70 ft. or 80 ft. long and it would have been extremely difficult to put them down under the interior, while they would not be assured of proper lateral support owing to the great depth of the mud bed. The pneumatic system was considered to be out of the question. Adequate foundations would be prohibitive in cost, and even if they were built the structure itself would still be in a wrecked and unsatisfactory condition. For this reason Mr. Cappelen advised the Board of Armory Commissioners to remove the building, salvaging the trusses and material and perhaps leaving the riding hall, as the settlement here was light.

Owing to urgent need for the building for war services, however, the Board of Armory Commissioners felt justified in going to considerable expense to make it fit for temporary use, and a committee of engineers, architects and builders was appointed to investigate the matter further. This committee reported in March, 1918, that in the foundations of some of the walls and interior footings the piles were not only inadequate in number but did not reach the underlying stratum of sand. At other places the piles did penetrate the stratum sufficiently to make it certain that further settlement would be slow and might decrease. The committee recommended the removal of the three-story portion of the main building, and also of the adjacent main steel truss of the drill hall, as this latter would be left without lateral support, and had settled over 2 ft. at the west end. This was concurred in by Mr. Cappelen, in a report to the city council.

Alterations carried out to reinforce the high, arched roof of the drill hall included placing four lines of longitudinal struts connecting the trusses, and longitudinal diagonal bracing between the steel columns supporting these trusses, as shown on the drawing. The first-floor slab was left intact, as it ties the whole structure together. The floor was leveled from the old slab. Temporary walls of frame and stucco were built to inclose

the parts left open and to give a reasonably good appearance. The building as thus altered has been in use since October, 1918.

When this work was practically completed Mr. Cappelen found that the wrecking had not been done as suggested by the committee and concurred in by him, but that the heavy main truss had been left in place. Having no connection with the work, he simply reported the fact to the city council, so as to be on record in case anything should develop in the future. The steel trusses are said to show no signs of distress, in spite of the settlement of their supports.

Brick Chimney Carried On Platform At Roof Of Building

Concrete Slab Footing Is Supported From Ground By Separate Columns—Chimney Has Unusual High Taper

By J. G. Mingle

The Rust Engineering Company, Cleveland, Ohio

TWO features distinguish the brick chimney, illustrated herewith, recently completed for the power house of the Cleveland Electric Illuminating Co.; one is the large bottom diameter and consequent taper, the other is the method of support at the roof of the building.

The chimney, which is of the perforated radial brick type, is built on top of the power house and is supported by a reinforced-concrete and steel platform on top of 12 fabricated steel columns extending down through the building and resting on separate grillages. The top of the platform is approximately 105 ft. above the basement-floor level. The peculiar shape and great taper of the structure are due to the flue opening in the concrete platform which is 10 ft. wide and 37 ft. long, around and over which the chimney is built.

The height of the chimbney is 163 ft. above the top of the platform; the inside diameter at the top is 20 ft. and the outside diameter at the base is 43 ft. The radial brick wall is 20 in. thick at the bottom and decreases by sections, with an average decrement of 1 in. per 16 ft., to 10 in. at the top. The taper of the chimney varies from 0.016 ft. per foot for the top section to 0.240 ft. per foot for the bottom section.

Reinforcement is provided both vertically and circumferentially, to resist any tensile stresses which may occur. The circumferential reinforcement consists of 4 x $\frac{5}{16}$-in. bands of strap steel bolted together in sections and embedded in the brickwork at vertical intervals of from 20 ft. at the top to 5 ft. at the bottom.

The vertical reinforcement consists of $\frac{3}{4}$-in. twisted square rods spaced on approximately 5-ft. centers and also embedded in the brickwork. The chimney is lined on the inside with perforated radial brick to a height of 26 ft. The lining is so arranged that it serves the double purpose of protecting the outside wall and preventing the soot from collecting on top of the platform. The brickwork is laid up in 2 cement, 3 lime and 5 sand mortar. It was necessary to make the mortar fairly stiff to keep the brick from slipping when they were being laid up. The brick are red in color. The chimney is designed to withstand a wind of 100 miles per hour with no tension at the windward side and a maximum compression of 15 tons per square foot at the leeward side. The weight of the entire chimney, including the lining, is approximately 1200 tons. It was designed and built by the Rust Engineering Co., of Pittsburgh, Penn.

HIGH AND WIDE BRICK CHIMNEY CARRIED ON STEEL COLUMNS REACHING CLEAR TO GROUND

Effect of War on Manganese Ore Industry

Prior to the European war the United States produced less than 1 per cent of its manganese requirements. The remainder was imported mainly from India, Russia and Brazil in the form of ore, and from Great Britian in the form of ferromanganese. It is noted that the countries possessing the largest and richest deposits have an abundant and cheap labor supply. Under war conditions India and Russia were practically eliminated as sources of supply. The productive capacity of the world's major deposits is much greater than the total demand for ore for steel making. The industry considerably expanded in Brazil and in Cuba during the war period. The large supplies from these nearer countries, together with the increased domestic output, proved greater than even the enormously expanded needs of this country. The United States became independent of British ferromanganese and of Indian and Russian ore. Domestic production of high-grade (i.e., 35% or more manganese) ore, used largely for making ferromanganese, increased from 4063 tons in 1913 to about 294,000 tons in 1918. Production of low-grade (less than 35% manganese) ore, used partly for making spiegel and partly smelted direct in iron furnaces, increased from 85,588 tons in 1913 to over 1,079,000 tons in 1918.

General Solution of Problems in Railway Compound Curves

Fundamental Equations Are Derived and Applied to Several Usual Cases Encountered in Railway Practice—Shifting and Revolving of Tangents Considered

By Antonio Llano
Montclair, N. J.

General Equations and Problems

FOR THE solution of problems in compound circular curves connecting two tangents, previous writers have failed to use the valuable principle of generality and have sometimes complicated the subject by a false appearance of simplicity. Some general equations are here derived and discussed. These equations are applied to several of the common problems in railroad curves, arising especially in street-railway work. The problems of shifting a tangent parallel to itself and of turning a tangent about its tangent point are solved by shorter methods than those usually given in textbooks on the subject.

Referring to Fig. 1, let $t_1 = T_1C$ and $t_2 = CT_2$ be two tangents to be joined by a compound curve. The exterior angle of intersection is denoted by Δ, the chord

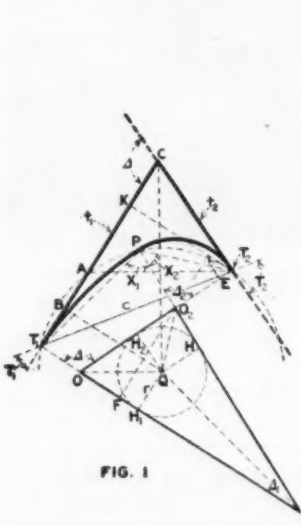


FIG. 1

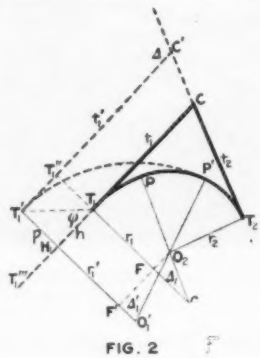


FIG. 2

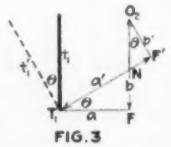


FIG. 3

FIG. 1. DIAGRAM SHOWING FUNDAMENTAL PROPERTIES OF COMPOUND CURVES. FIG. 2. SHIFTING A TANGENT TO A PARALLEL POSITION. FIG. 3. TURNING A TANGENT ABOUT ITS TANGENT POINT

T_1T_2 by c, and the angles between the chord and the tangents by T_1 and T_2, as shown. The heavy curve T_1PT_2 is one of the possible compound curves, P being the point of tangency of the two branches. The centers O_1 and O_2 of the branches T_1P and PT_2 lie in the normals T_1O_1 and T_2O_2 to t_1 and t_2, respectively, which meet at O. Since the angle T_1OT_2 is the supplement of the interior angle C, it is equal to Δ. The radii T_1O_1 and T_2O_2 will be denoted by r_1 and r_2, respectively, and the central angles by Δ_1 and Δ_2.

The determination of the locus of the variable point P is convenient both for the derivation of the general formulas and for the graphic solution and discussion of problems. Take $CA = CT_2$, and draw AT_2, PT_1 and PT_2. In the triangle OO_1O_2,

$$\Delta_1 + \Delta_2 = \Delta$$

Since the two triangles PO_1T_1 and PO_2T_2 are isosceles, $x_1 = 90° - \Delta_1/2$ and $x_2 = 90° - \Delta_2/2$, and therefore $T_1PT_2 = x_1 + x_2 = 180° - (\Delta_1 + \Delta_2)/2 = 180° - \Delta/2$. It follows that the locus of P is an arc described on c such that all angles inscribed in it shall be equal to $180° - \Delta/2$. The following is the simplest way of determining the center of that arc. In the triangle CAT_2, angle $CAT_2 = \Delta/2$, and also

$$T_1AT_2 = 180° - CAT_2 = 180° - \Delta/2.$$

Therefore, the required arc must pass through A; hence its center Q is the center of the circle circumscribed about the triangle AT_1T_2, and is at the intersection of the perpendicular bisectors BQ and CQ of AT_1 and AT_2, the perpendicular CQ being also the bisector of the interior angle at C. The arc is shown in dotted lines.

Although the arc just determined is the locus of P, not every line drawn from it cutting the two normals determines the centers of two circles fulfilling the conditions; for the line PO_2O_1 must fulfill another condition not involved in the mere fact that it cuts the normals and the arc. The line QO_2, being the line of centers of two circles meeting at P and T_2, bisects the angle Δ_2 made by the radii drawn from O_2 to the points of intersection. For a like reason, QO_1 bisects Δ_1. Therefore, Q is the point of intersection of the bisectors of the triangle OO_1O_2, and hence also the center of the circle inscribed in that triangle. The points of tangency of this circle with the three sides are denoted by H_1, H_2 and H, and the radius by r. From the figure,

$$r = QH_1 = BT_1 = AT_1/2 = (t_1 - t_2)/2$$

Any line tangent to the arc H_1HH_2 and bounded by the arc T_1AT_2 and the normal T_1O produced determines one value for each of the quantities r_1, r_2, Δ_1, Δ_2. It will be observed that only one of these quantities can be assumed at pleasure when t_1, t_2 and Δ are given.

Derivation of the Fundamental General Equations—As it is convenient sometimes to use the half angles, and sometimes the whole angles, two systems of equations will be derived.

Fig. 1 gives

$$T_1H_1 = BQ = BC \tan C/2 = \frac{t_1 + t_2}{2} \cot \Delta/2$$

Also,

$$T_1H_1 = r_1 - O_1H_1 = r_1 - \frac{t_1 - t_2}{2} \cot \Delta_1/2$$

Therefore

$$\frac{t_1 + t_2}{2} \cot \Delta/2 = r_1 - \frac{t_1 - t_2}{2} \cot \Delta_1/2 \qquad (a)$$

Interchanging t_1 and t_2, r_1 and r_2, Δ_1 and Δ_2:

$$\frac{t_1 + t_2}{2} \cot \Delta/2 = r_2 - \frac{t_2 - t_1}{2} \cot \Delta_2/2 \qquad (b)$$

Equations (a) and (b) can be transformed thus:

$$(t_1 + t_2) \cot \Delta/2 + (t_1 - t_2) \cot \Delta_1/2 = 2r_1 \quad (A_1)$$

$$(t_2 + t_1) \cot \Delta/2 + (t_2 - t_1) \cot \Delta_2/2 = 2r_2 \quad (A_2)$$

These are the fundamental half-angle equations. Together with the equation $\Delta_1 + \Delta_2 = \Delta$, they form a system of three independent equations by which any three of the quantities involved can be computed when

the others are known. As there are seven quantities, any four of them can be assumed at random, with the only limitation that Δ, Δ_1 and Δ_2 cannot all three be assumed, since they are connected by the relation just mentioned. This does not mean that any assumed values will lead to practical solutions; but the cases of impossibility will be indicated by the resulting equations themselves, as when a negative value is found for one of the radii or angles. Equations (A_1) and (A_2), when taken together, will be called system (A).

Whole-Angle Equations—The whole-angle equations can be derived by successive transformations of equations (A), but it is simpler to derive them directly from Fig. 1. Draw T_2K perpendicular to t_1 and EO_2F perpendicular to T_1O_2, and therefore parallel to t_1. The angle ET_2O_2 is equal to 180° — Δ (quadrilateral OK). Now

$$\begin{aligned} t_2 \sin \Delta &= KT_2 = KE + ET_2 \\ &= T_1F + r_2 \cos (180° - \Delta) \\ &= r_1 - FO_1 - r_2 \cos \Delta \\ &= r_1 - (r_1 - r_2) \cos \Delta_1 - r_2 \cos \Delta \end{aligned} \qquad (c)$$

Interchanging subscripts:

$$t_1 \sin \Delta = r_2 - (r_2 - r_1) \cos \Delta_2 - r_1 \cos \Delta \qquad (d)$$

Writing (1 — vers) instead of cos, (d) and (c) take the following forms:

$$t_1 \sin \Delta = r_1 \operatorname{vers} \Delta + (r_2 - r_1) \operatorname{vers} \Delta_2 \qquad (B_1)$$

$$t_2 \sin \Delta = r_2 \operatorname{vers} \Delta + (r_1 - r_2) \operatorname{vers} \Delta_1 \qquad (B_2)$$

Sometimes the chord c and the angles T_1 and T_2 are given instead of t_1 and t_2. In that case equations (A) and (B) are transformed thus: From trigonometry,

$$t_1 - t_2 = \frac{c \sin (T_1 - T_2)/2}{\sin \Delta/2}$$

$$t_1 + t_2 = \frac{c \cos (T_1 - T_2)/2}{\cos \Delta/2}$$

Substituting in (A) and transforming:

$$c \sin \frac{T_1 - T_2}{2} [(\cot \Delta_1/2 + \cot (T_1 - T_2)/2] = 2r_1 \sin \Delta/2 \qquad (A'_1)$$

$$c \sin \frac{T_2 - T_1}{2} [(\cot \Delta_2/2 + \cot (T_2 - T_1)/2] = 2r_2 \sin \Delta/2 \qquad (A'_2)$$

The equations of system (B) are transformed by writing

$c \sin T_2/\sin \Delta$ for t_1 and $c \sin T_1/\sin \Delta$ for t_2,

which gives

$$c \sin T_2 = r_1 \operatorname{vers} \Delta + (r_2 - r_1) \operatorname{vers} \Delta_2 \qquad (B'_1)$$

$$c \sin T_1 = r_2 \operatorname{vers} \Delta + (r_1 - r_2) \operatorname{vers} \Delta_1 \qquad (B'_2)$$

The equations will now be applied to the solution of some of the usual problems.

(a) ***Given the two tangents and their angle of intersection, and one of the radii (or the corresponding degree of curve), to compute the other radius and the central angles.***

Suppose r_1 to be given, to determine Δ_1, Δ_2 and r_2. Equation (A_1) at once gives

$$\cot \Delta_1/2 = \frac{2r_1 - (t_1 + t_2) \cot \Delta/2}{t_1 - t_2} \qquad (1)$$

Then, $\Delta_2 = \Delta - \Delta_1$, and r_2 is found from (A_2).

If c, T_1 and T_2 are given instead of t_1 and t_2, use the system (A′).

(b) ***Given the lengths and degrees of curve of the two branches of a compound curve; or, what is the same thing, given r_1 and r_2, and the angles Δ_1 and Δ_2 ($= \Delta - \Delta_1$), to find the tangent points; that is, the tangent distances t_1 and t_2.***

As already stated, this problem is perhaps the most common. At first sight it may seem that equations (B), which at once give t_1 and t_2, are the better to use in this case. They are preferable for rough work, using natural functions; but for accurate work the equations (A) lead to simpler results, involving easier computation. The process consists in calculating $(t_1 + t_2)/2$ and $(t_1 - t_2)/2$ and then t_1 and t_2 by the equations

$$t_1 = (t_1 + t_2)/2 + (t_1 - t_2)/2 \qquad (2)$$

$$t_2 = (t_1 + t_2)/2 - (t_1 - t_2)/2 \qquad (3)$$

Subtracting (A_2) from (A_1):

$$(t_1 - t_2) (\cot \Delta_1/2 + \cot \Delta_2/2) = 2(r_1 - r_2)$$

whence, solving for $(t_1 - t_2)/2$ and replacing cot by cos/sin,

$$(t_1 - t_2)/2 = \frac{(r_1 - r_2) \sin \Delta_1/2 \sin \Delta_2/2}{\sin \Delta/2} \qquad (4)$$

Having computed $(t_1 - t_2)/2$, equation (A_1) gives

$$(t_1 + t_2)/2 = [r_1 - \frac{t_1 - t_2}{2} \cot \Delta_1/2] \tan \Delta/2 \qquad (5)$$

and t_1 and t_2 are found by equations (2) and (3).

(c) ***Given one of the tangent points, the two radii and the angle Δ, to find the other tangent point and the central angles.***

Suppose t_1, Δ, r_1 and r_2 to be given, to find Δ_1, Δ_2, and t_2.

In this case the equations (A) are not convenient, and the equations (B) are used.

From (B_1):

$$\operatorname{vers} \Delta_2 = \frac{r_1 \operatorname{vers} \Delta - t_1 \sin \Delta}{r_1 - r_2} \qquad (6)$$

Then, $\Delta_1 = \Delta - \Delta_2$, and ($B_2$) gives

$$t_2 = \frac{r_2 \operatorname{vers} \Delta + (r_1 - r_2) \operatorname{vers} \Delta_1}{\sin \Delta} \qquad (7)$$

For logarithmic work it is better to compute $t_1 - t_2$ by equation (4), after Δ_1 and Δ_2 have been found, and then t_2. One should not be deceived by the apparent simplicity of such expressions as the second member of (7). The arithmetical work involved is very laborious. The logarithmic work in (4), being more uniform and in a certain sense more mechanical, is much easier and safer.

It should be understood that the preceding formulas are entirely general. It is immaterial whether in them t_1 is greater or less than t_2, or which of the two tangents is called t_1 and which t_2. Furthermore, from every equation another similar equation can be obtained by interchanging the subscripts. It is thus that (A_2) is obtained from (A_1), and (B_2) from (B_1). The same remark applies to all the problems that follow. This fact is here emphasized because writers complicate the subject by making separate problems of special cases which, being included in the general equations, do not require independent treatment.

Shifting One Tangent Parallel to Itself

It is often necessary or convenient, after the elements of a compound curve have been calculated, to shift one of the tangents parallel to itself a given distance, leaving the position of the other tangent and the corresponding radius and point of tangency unaltered. Referring to Fig. 2, let T_1PT_2 be a given compound curve, the notation being as in Fig. 1. Let the tangent t_1 be shifted to the position t'_1, parallel to and distant p from t_1. Let $T'_1P'T_2$ be a new compound curve connecting t'_1 and t_2, the point T_2 and the radius r_2 remaining unchanged; O'_1 the center of the branch T'_1P', r'_1 the radius, and Δ'_1 the central angle.

Geometrically, the problem is to determine a circle that shall be tangent to the given circle O_2 and the given line t'_1. The problem would be indeterminate if t'_1 were not located with reference to O_2, and it is for this purpose that r_1 and Δ_1 are utilized; that is, they determine the position of t'_1 with respect to O_2. For, drawing O_2FF' perpendicular to the normals T_1O_1 and $T'_1O'_1$, and producing O_2T_1 to T''_1 on t'_1, we have

$$\begin{aligned} FT''_1 &= FT_1 + p \\ &= r_1 - (r_1 - r_2)\cos\Delta_1 + p \\ &= r_2 + (r_1 - r_2)\text{vers}\,\Delta_1 + p \end{aligned} \qquad \text{(a)}$$

In order to locate T'_1 from T_1, it is necessary to know the distance $h = T_1H_1$. The variable elements to be introduced are therefore r'_1, Δ'_1 and h. There is a system of two independent equations by means of which any two of them can be determined when the other is known. Those equations will now be derived.

The figure gives

$$\begin{aligned} FT''_1 = F'T'_1 &= r' - F'O'_1 = r'_1 - (r'_1 - r_2)\cos\Delta'_1 \\ &= r_2 + (r'_1 - r_2)\text{vers}\,\Delta'_1 \end{aligned}$$

From this and (a) follows

$$(r'_1 - r_2)\text{vers}\,\Delta'_1 = (r_1 - r_2)\text{vers}\,\Delta_1 + p$$

We have also

$$\begin{aligned} h = FF' &= O_2F' - O_2F \\ &= (r'_1 - r_2)\sin\Delta'_1 - (r_1 - r_2)\sin\Delta_1 \end{aligned}$$

The fundamental system of equations is therefore

$$(r'_1 - r_2)\text{vers}\,\Delta'_1 = (r_1 - r_2)\text{vers}\,\Delta_1 + p \qquad (C_1)$$

$$(r'_1 - r_2)\sin\Delta'_1 = (r_1 - r_2)\sin\Delta_1 + h \qquad (C_2)$$

If the tangent to be shifted is t_2, interchange the subscripts. If the tangent is to be shifted inwards, make p negative. A negative value of h indicates that H_1 lies between T_1 and C. Conversely, if, when H_1 is given, it lies between T_1 and C, make h negative. It is unnecessary to treat all these cases independently. To locate T'_1 directly from T_1:

$$\tan\phi = p/h \text{ and } T_1T'_1 = p/\sin\phi$$

The three problems that may arise will be briefly considered, mainly to call attention to some special cases. In order to avoid confusion, the formulas applying to such cases will be numbered with prime numbers, lest they should be taken for general formulas.

(d) *Given* Δ'_1, *to find* r'_1 *and* h. *Solve* (C_1) for r'_1, and then (C_2) for h.

If $\Delta'_1 = \Delta_1$, (C_1) gives

$$r'_1 = r_1 + p/\text{vers}\,\Delta_1 \qquad (1')$$

Substituting in (C_2), solving for h and transforming:

$$h = p\cot\Delta_1/2 \qquad (2')$$

It follows that

$$\phi = \Delta_1/2 \text{ and } T_1T' = p/(\sin\Delta_1/2) \qquad (3')$$

(e) *Given* r_1, *to find* Δ'_1 *and* h. Solve (C_1) for Δ'_1, and then (C_2) for h

If $r'_1 = r_1$, (C_1) gives

$$\text{vers}\,\Delta'_1 = \text{vers}\,\Delta_1 + \frac{h}{r_1 - r_2} \qquad (4')$$

From (C_2) and (C_1)

$$\frac{h}{p} = \frac{\sin\Delta'_1 - \sin\Delta_1}{\text{vers}\,\Delta'_1 - \text{vers}\,\Delta_1} = \frac{\sin\Delta'_1 - \sin\Delta_1}{\cos\Delta_1 - \cos\Delta'_1} = \cot(\Delta_1 + \Delta'_1)/2$$

whence

$$h = p\cot(\Delta_1 + \Delta'_1)/2 \qquad (5')$$

$$\phi = (\Delta_1 + \Delta'_1)/2 \qquad (6')$$

(f) *Given* h, *to find* Δ'_1 *and* r'_1. Dividing equation (C_2) by (C_1),

$$\tan\Delta'_1/2 = \frac{(r_1 - r_2)\text{vers}\,\Delta_1 + p}{(r_1 - r_2)\sin\Delta_1 + h} \qquad (8)$$

Now r'_1 is found by either (C_1) or (C_2).

If it is desired that the new tangent point should be on the same normal or radial line as before (at T''_1), $h = 0$, and (8) becomes

$$\tan\Delta'_1/2 = \tan\Delta_1/2 + \frac{p}{(r_1 - r_2)\sin\Delta_1} \qquad (7)$$

Also, from (C_2),

$$r'_1 = r_2 + \frac{(r_1 - r_2)\sin\Delta_1}{\sin\Delta'_1} \qquad (8')$$

(g) *Given a compound curve, to shift one of the tangent points along the same tangent, without changing the other tangent nor tangent point, nor the other radius.* Referring to Fig. 2, the problem is to shift T_1 to another point, as T'''_1 on the tangent CT_2, without changing t_2 nor r_2.

This problem, which occurs mainly in street railroad construction, is but a special case of that of shifting a tangent parallel to itself. The three cases that may occur are solved by making $p = 0$ in equations (C). The distance h is the distance $T_1T'''_1$ that the tangent point is shifted. System (C) can easily be reduced, in this case, to the following form, which expedites the solutions:

$$(r'_1 - r_2)\text{vers}\,\Delta'_1 = (r_1 - r_2)\text{vers}\,\Delta_1 \qquad (C'_1)$$

$$(r_1 - r_2)\text{vers}\,\Delta_1(\cot\Delta'_1/2 - \cot\Delta_1/2) = h \qquad (C'_2)$$

Turning a Tangent About Its Tangent Point

Given a compound curve, to change it so that one of the tangents may be turned about its tangent point through a given angle without changing the other tangent nor the radius corresponding to the other tangent, nor either tangent point.

Referring to Fig. 3, where t_1 is the original tangent, O_2 the center of the r_2 curve, as in Fig. 2, and O_2F is perpendicular to the normal to t_1 at T_1, the problem is to turn t_1 through an angle θ to the position t'_1, and determine the elements r'_1 and Δ'_1 (not shown) so that the curve shall still begin (or end) at T_1, with O_1 and r_2 remaining unchanged. This problem occurs in connection with changes of alignment. Some writers solve it by the analytic geometry of conic sections. The following solution is simpler:

From Fig. 2 the following values are obtained for the distances denoted in Fig. 3 by a and b:

$$\begin{aligned} a = T_1F &= r_1 - (r_1 - r_2)\cos\Delta_1 \\ &= r_2 + (r_1 - r_2)\text{vers}\,\Delta_1 \end{aligned} \qquad (9)$$

$$b = FO_2 = (r_1 - r_2)\sin\Delta_1 \qquad (10)$$

Fig. 3 gives

$$\begin{aligned} a' = b\sin\theta + a\cos\theta &= (r_1 - r_2)\sin\theta\sin\Delta_1 \\ &+ r_1\cos\theta - (r_1 - r_2)\cos\theta\cos\Delta_1 \end{aligned}$$

that is

$$a' = r_1\cos\theta - (r_1 - r_2)\cos(\Delta_1 + \theta) \qquad (11)$$

Likewise

$$b' = b\cos\theta - a\sin\theta = (r_1 - r_2)\sin(\Delta_1 + \theta) - r_1\sin\theta \qquad (12)$$

Applying (9) and (10)) to the r'_1 curve, we have

$$(r'_1 - r_2)\text{vers}\,\Delta'_1 = a' - r_2 \qquad (13)$$

$$(r'_1 - r_2)\sin\Delta'_1 = b' \qquad (14)$$

whence, by division

$$\tan\Delta'_1/2 = \frac{a' - r_2}{b'} = \frac{r_1\cos\theta - (r_1 - r_2)\cos(\Delta_1 + \theta) - r_2}{(r_1 - r_2)\sin(\Delta_1 + \theta) - r_1\sin\theta}$$

or, transforming,

$$\tan\Delta'_1/2 = \frac{(r_1 - r_2)\text{vers}(\Delta_1 + \theta) - r_1\,\text{vers}\,\theta}{(r_1 - r_2)\sin(\Delta_1 + \theta) - r_1\sin\theta} \qquad (15)$$

Now r'_1 can be found from (14) and (12).

If t_2 is the tangent to be turned, interchange the subscripts. If the tangent is turned inward, change the sign of θ.

How the Engineers of Iowa Got a Registration Law

Personal Study on the Ground, Backed by Coöperating Organizations and Individuals, Is Accountable for Success

By J. H. Dunlap

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ORGANIZATION, analysis of past failures, a continuous, scientific study, by engineers on the ground, of each legislative delay, personal contact with the legislators, and coöperation by all engineering organizations and all engineers in the state, are responsible, in a prominent degree, for the success attained recently in Iowa in making the proposed registration bill a law. The favorable action of the General Assembly was based on the conviction impressed upon it that the time had now come when the public should be protected, so far as law may protect it, from incompetent and reckless engineers, as had already been done in the cases of physicians and lawyers. To show just how the work was done is the purpose of this article.

An analysis of past failures showed that there had been, first, a lack of general coöperation among the engineers of the state both in preparing the bill for presentation to the legislature and in backing the bill before the legislature, and, second, a lack of scientific management of the bill after it had been introduced in the legislature. This lack of scientific management was usually confined to the public hearing before the committee to which the bill had been referred. The chairmen of the committees on legislation have found it a task to bring despair, to get together three or four engineers who could talk intelligently and persuasively before a committee of legislators in regard to the benefits of an engineers' license bill.

Sample of Engineering Oratory

The customary speech of an engineer when called to his feet by the committee was very much as follows: "Gentlemen, I believe this bill is a good one. I am sorry to say that I have not had time to think up any speech and I don't think it is necessary." And then our engineering orator would resume his seat in much confusion of mind and body, and proceed to mop the perspiration from his brow. The result of such tactics was, justly, that the committee would almost invariably slate the bill for indefinite postponement. In other words, no scientific study was made of just how to create the right attitude toward the bill by each member of the committee, before the bill was voted on in the committee.

Having learned something from our habitual failures, we tried the following procedure—this time with success. In order to secure the widest coöperation among the engineers of the state, irrespective of their membership in the Iowa Engineering Society, it was decided to hold at Des Moines, June 8, 1918, a joint conference of all the engineers and engineering and architectural organizations of the state. As a result of this joint conference, a committee representing each one of these organizations was appointed, with C. H. Young, president of the Iowa Engineering Society, as chairman and the writer as secretary. This committee was instructed to draft an engineers' registration bill, to submit it to all the engineers and to all organizations that would be affected by the law, and then to call a second joint conference to discuss the proposed bill.

After a study of the bills which had been enacted or proposed recently, a bill was drafted which was modeled closely on the Florida law and on the law suggested by the Joint Committee of the national engineering societies Feb. 4, 1915. This first draft of the bill was submitted to an informal group of interested engineers, was criticized and then was rewritten. Copies of the bill were then sent to a mailing list, reaching, it was hoped, every engineer in the state. Accompanying the bill was a call to a second joint conference Jan. 25, 1919.

At this conference each section of the bill was thoroughly discussed, and in many cases amendments were made. After a session nearly six hours long the final draft of the bill was approved as amended. The motion then prevailed that a committee be appointed to prepare copies of the bill as amended, to have the bill examined from a legal point of view by the attorney provided by the office of the Attorney General for such purpose, and then to submit the bill in its final form to the legislature which was soon to assemble. The chairman of the conference, Mr. Young, appointed an executive committee of five members, an advisory committee of eight members, and a promotion committee of 31 members.

Senator Takes Charge of Bill

Senator J. D. Buser, becoming convinced of the good points of the bill, consented to take charge of it in the Senate. He introduced it Feb. 11, 1919. It was referred to the committee on roads and highways. It was later thought best to have the bill transferred to the committee on cities and towns, which was easily arranged. At the public hearing before this committee, a few interested engineers appeared and tried to enlighten the members of the committee in regard to the good points of the bill. As usual, however, the same result came to pass—namely, the bill was slated for indefinite postponement.

At this juncture it was decided to make a scientific study to decide exactly what was the trouble. Accordingly, two engineers were dispatched to Des Moines, Mar. 20, to study this problem with the same thoroughness that engineers are accustomed to give to problems of other kinds. From this point on, the most careful personal attention was given to each problem as it presented itself, with the result that the bill came out of the committee promptly and was passed by the Senate Mar. 26, with a few amendments, by a vote of 28 ayes, 16 nays, with six absent or not voting. Since the constitutional majority was 26, there were two votes to spare. Great credit for this successful result is due the engineers of the state who responded quickly to telegrams sent them two days before, asking them to get into personal touch with the senators from their districts.

Before the adjournment of the Senate for the day, it was learned that one of the senators had moved to reconsider the vote by which the bill had passed the Senate. By conference with him, it was learned that he wished to amend the bill so that private systems could be extended and constructed without the necessity of employing registered engineers, and also to amend the bill so that surveys, in all cases except where contests were involved, could be made by unregistered surveyors. Believing that it would be dangerous to have

the bill reconsidered on the floor of the Senate because of the small margin of safety in the vote, every effort was made to persuade the senator to withdraw his motion to reconsider. He finally consented to do so, when given a gentlemen's agreement that his desired amendments would be offered in the House.

In the House the bill was referred to the committee on municipal corporations. The progress of the bill in the committee was carefully watched by two engineers, assisted by such others as were available from time to time. The bill was reported out favorably by the committee just in time to be placed in the hands of the sifting committee, which had been appointed that very day to decide which bills, of the large number remaining to be acted upon, should be brought before the House. The problem presented by the sifting committee was carefully studied, since to lose at this point would have been to lose all. As a result, the bill was promptly reported out to the House, with the amendments proposed which had been agreed upon with the senator.

On Apr. 14 the bill was passed by the House by a vote of 81 ayes, 10 noes, and 17 absent or not voting. As the constitutional majority in the House was 55, the bill was declared to have passed the House.

The heavy vote in favor of the bill is a testimonial to the personal efforts of engineers in every county of the state in bringing the bill to the intelligent consideration of the representatives from their districts. It is impossible to place too much emphasis upon careful organization work of this kind. All such work should be reported back to those in personal charge of the work for the bill in the state house, in order that proper records and information may be instantly at hand when needed.

On Apr. 15 the Senate concurred in the House amendments with a vote of 35 ayes, no noes, and 15 absent or not voting. On Apr. 25 the bill was signed by the Governor.

Generous use of the telegraph and of the long-distance telephone, continuous scientific study, with characteristic engineering thoroughness, of each problem presented, and coöperation by all engineering organizations and all engineers in the state are responsible for the success of the bill. In personal conference with individual representatives it proved very helpful to have on hand a supply of brief abstracts of the bill, together with a brief list or arguments against the bill. The use of specific instances in which the bill, if it became law, would operate to prevent existing difficulties proved very effective. Many of the legislators seemed surprised when told that there was yet no law to prevent any one of them from hanging out his shingle and selling his services as an engineer anywhere in Iowa. When told, however, that he could not do this in Illinois, he usually concluded that Iowa should emulate her sister state.

Pennsylvania's Record Week in Road Letting

Reports from the Bureau of Public Roads, United States Department of Agriculture, indicate that Pennsylvania holds the record for amount of road work let in any one week. During the week ending Apr. 12 contracts were awarded for $2,034,378. This is considered an indication of the resources that will be enlisted in highway construction in this country in the near future. Of the contracts mentioned, the Federal Government will pay $911,407, under the Federal-aid act.

Cost of Operating Trucks on Highway Maintenance in Illinois

By B. H. Piepmeier
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DETAILS of the cost of operating five light trucks in maintenance work on Illinois highways are shown in the accompanying table giving figures for 1917 and 1918. The higher costs for the latter year are accounted for by the higher price of supplies and the greater age of the cars, two of which were new at the beginning of 1917. Trucks numbered 1, 3 and 5 are Ford cars converted into trucks; those numbered 2 and 4 are Ford-Smith Form-a-Trucks. All the trucks are subjected to very severe usage on account of the bad roads between jobs and the excessive loads they are compelled to carry at times. Annual depreciation on the cars is usually computed at about one-third their value, this figure being varied slightly each year to fit the general condition of the car upon completion of the season's work.

COST OF OPERATING ROAD-MAINTENANCE TRUCKS IN ILLINOIS

Truck No.	1	2	3	4	5
Type	Ford	Ford-Smith	Ford	Ford-Smith	Ford
Investment	$602.40	$795.53	$419.80	$784.54	$383.55
Figures for 1917					
Fixed charges per year:					
Interest	$20.33	$26.85	$14.17	$26.48	$12.94
License	4.00	4.00	4.00	4.00	4.00
Storage	38.20	124.73	20.00	25.60	67.55
*Total fixed charges	$62.53	$155.58	$38.17	$56.08	$84.49
Charges based on total mileage for year:					
Fuel and lubricants	$125.81	$210.39	$119.68	$182.92	$141.34
Mechanical repairs	72.01	73.40	76.91	148.08	76.25
Tires	82.45	12.75	75.45	28.00	119.53
Depreciation (computed)	279.63	325.72	152.63	399.31	220.16
Total mileage charges	$559.90	$622.26	$424.67	$758.31	$557.28
Total maintenance cost	$622.43	$777.84	$462.84	$814.39	$641.77
Miles traveled	6,963	6,141	5,453	7,635	8,610
Cost, cents per mile	8.94	12.67	8.12	10.67	7.45
Figures for 1918					
Fixed charges per year:					
Interest	$20.33	$26.85	$14.17	$26.48	$12.94
License	6.00	6.00	6.00	6.00	6.00
Storage	76.50	108.53	36.30	65.55	41.25
*Total fixed charges	$102.83	$141.38	$56.47	$98.03	$60.19
Charges based on total mileage per year:					
Fuel	$109.76	$143.78	$60.06	$184.01	$94.76
Lubricants	23.60	49.00	8.50	41.02	17.68
Mechanical repairs	250.75	231.35	242.42	525.86	94.82
Tires	127.82	52.06	96.56	139.83	114.59
Depreciation (estimated)	165.99	300.00	139.84	350.00	150.00
Total mileage charges	$677.92	$776.19	$547.38	$1240.72	$471.85
Total maintenance cost	$780.75	$917.57	$603.85	$1338.75	$532.04
Miles traveled	5,460	6,276	4,300	7,900	5,200
Cost, cents per mile	14.30	14.62	14.04	16.95	10.23

* Wages of chauffeur and insurance omitted.

British Concrete Colliers Have Precast Sides

Concrete colliers of a capacity of 1000 tons are being built for the British Admiralty by the firm of Christiani & Nielsen, of London. These boats are 185 ft. long, of 35-ft. beam and 18 ft. deep, and are novel on account of the method of casting the straight sides. The ships have a minimum of molded lines, a large proportion of the section being vertical straight sides with a flat bottom. The sides, which are composed of heavy vertical stringers and intermediate horizontal cross-beams, are cast horizontally on a flat platform, and after having attained their set are raised to the vertical position. Protruding rods are left for the bottom and deck. The curved bow and stern, being cast in place, have a shell 5 in. thick, as against the 3½-in. thickness for the precast sides.

LETTERS TO THE EDITOR

Comment on Matters of Interest to Engineers and Contractors Will Be Welcome

Engineers' Versus Laborers' Compensation

Sir—There is a curious letter in your issue of May 8, 1919, p. 931, from a young man, apparently 18 years of age, who received about $160 a month, including overtime, as a day laborer on an aviation field last summer, during the war, and whose spirit, in consequence, moves him to make invidious remarks about the opportunities for money-making offered by the engineering trade. He feels that it would be at least three years after graduation before a young engineer would receive a salary of $2000 a year. I feel that he is correct in feeling thus. He is rather dubious about the advisability of spending $1500 a year for four years in order to obtain an engineering education. I am rather dubious about the average young man obtaining the education if he spends the $1500. Most engineering students who spend this much become educated in matters quite interesting, perhaps, but not found in the school curriculums.

I would not have written this letter, however, were it not that the boy says he is dubious not only on account of the great wage he received as a laborer but on account of "similar conditions described by your readers." I have noticed these descriptions made quite frequently lately in letters to *Engineering News-Record*, and have wondered whether some of them might not have a serious effect upon some of your young readers who were thinking of becoming engineers. They evidently have had such effect upon, at least, one.

It is well, therefore, to iterate and reiterate the fact that an engineering education pays in money if in no other way. The laborer generally has to remain a laborer. The young graduate generally earns a fair salary at first—all he is worth, at first—and if he is able and continues to work very hard is sure to rise in his profession and be well paid. You will note I write only of payment in money, because the letters to your paper on this subject refer only to money—to the difference between the wages of laborers and the salaries of young engineers.

I certainly should be one of the last, for more than one reason, to criticize those who are trying to obtain better salaries for young engineers; but the cold fact remains that services, in the long run, receive the payment they are worth. The complaining letters are most frequently written by surveyors and draftsmen. The difficulty is that common surveying and ordinary drafting are not difficult to learn, and the law of supply and demand takes care of the pay for this kind of work. It is also a fact that a good carpenter is often worth more to a community than a good leveller or a good draftsman; but the opportunity of the leveller or draftsman to rise, if he has had a good education and works hard, is far better than that of the carpenter. It may be truly said of a young graduate of a good engineering school that he is self-supporting as soon as he begins his professional career and that, if he has average capacity and works hard, he need not let a laborer pass him in the running. Many presidents, managers and chief engineers of corporations, who have not written to *Engineering News-Record*, could substantiate this statement.

These remarks apply to other professions also, but the advantage in ours is that it costs less to obtain the necessary education and that young graduates become self-supporting much sooner than graduates of other professional schools; for instance, lawyers and physicians. And, in this age, it would be difficult to prove that even the later money rewards of lawyers and physicians average more than those of graduate engineers, so many of whom, as part owners or employees, have highly remunerative connections with large corporations.

PALMER C. RICKETTS,
President, Rensselaer Polytechnic Institute.
Troy, N. Y.

Sir—Reading the discussions in your journal about the compensation received by engineers never fails to interest me to a high degree. In your issue of May 8, 1919, p. 931, you print a letter by Lucien Alter, who apparently is very dubious about investing the necessary time and money to study engineering after comparing his earning capacity as a laborer with the earning capacity of his brother, a graduate of an engineering school.

Putting aside the fact that the high wages received by him are directly traceable to the urgency of war, I beg leave to ask Mr. Alter if his choice of a profession is solely guided by the expectation of making money.

If this is his predominant idea, I, as a graduate engineer who started work 25 years ago with the royal salary of $50 per month, would tell him very earnestly to divert his activities and energies into other channels. Such a frame of mind will surely prevent him becoming a real engineer—that is, a man who devotes his professional life to the creation of things useful to his fellow citizens and to mankind, and whose joy of life is derived from such work well done, irrespective of the size of the estate he may leave behind when he is called to the great beyond. GUSTAV A. STIERLIN.
Pittsburgh, Penn.

Accidents and Expert Checking of Engineering Plans

Sir—Burtis S. Brown's interesting article, "Details of the Failure of a 90-Ft. Molasses Tank," and the editorial comment thereon, in your issue of May 15, have induced me to send you these few lines calling attention to a paper which I wrote for you nearly two years ago, and which was published in your issue of Nov. 22, 1917, p. 979, under the title "Why Not Have All Designs Checked by Outside Experts?" In that paper I advocated the checking of plans for all important engineering constructions, more especially those in which failure would jeopardize human life, and having such checking done by expert engineers who had not been concerned in the designing. Had such a precaution been taken in the case of the molasses tank no failure would have occurred, and 12 human lives would have been spared, to say nothing of the great damages to property which would have been avoided. The most simple calculations would have located the weakness; and it could have been corrected at comparatively small expense.

Another late example of fruitlessly expended money

through failure to check the working plans is that of the foundations on the Rondout Creek bridge, constructed under a former Commissioner of Highways for the State of New York. The amount of money there wasted was $48,000.

It would not be difficult to resurrect a long list of serious failures in engineering work which could readily have been avoided by proper checking of plans; but, as I stated in my original communication, "so doing would raise animosities and cause hard feelings, which is something to be avoided whenever possible."

Cannot you use the powerful influence of your paper to materialize this much-needed innovation in engineering practice? By doing so you would confer a lasting benefit upon both the engineering profession and the general public.

J. A. L. WADDELL,
Consulting Engineer.

New York City.

Military Training and the Army's Construction Work

Sir—Capt. R. K. Tomlin, Jr., has shown me an extract from his letter to you in regard to your editorial in the issue of Feb. 27, 1919, p. 408, entitled "Civilians Did Army's Construction Work in the United States." His purpose in writing you, and mine in the interview to which he refers, should be made clearer.

Without wishing in the slightest degree to detract from the credit due for the work of the Construction Division, I deprecate any tendency on your part to create, even indirectly, the impression that a knowledge of military procedure and familiarity with the essentials of military organization are not of great value in connection with such operations as were performed by the Construction Division, and of still greater value when the construction operations take place, as they did in France, in the actual theater of war, where the main and only satisfactory labor was that of soldiers.

As you doubtless know, construction work for the Army in the United States in peace is assigned to the Quartermaster Corps, while similar work in war in the theater of operations is assigned to the Corps of Engineers. Realizing the fact that war upon a modern scale would employ men, munitions, supplies and materials to an extent hitherto unknown, either in war or peace, and call for an enormous expansion of all our military facilities and personnel, with a correspondingly large program of construction operations, some time before our entrance into the war the Chief of Engineers in the United States, taking advantage of a newly made provision of law, sought to interest the engineers of our country in the Engineer Reserve Corps. His efforts met with a gratifyingly large response on the part of the profession, so that even before we entered into the war the Reserve Corps had a large personnel, including many of the leading engineers of the United States.

When our entry into the war became imminent, accelerated efforts were made to enlarge the Engineer Reserve Corps, and the ultimate result was that the number of engineer officers in our Army, which in the peace establishment amounted to something over 200, grew during the war to over 8000, most of whom were employed in France, although many were necessarily retained in the United States on work of supply, administration and organization. As many as possible of these engineer officers, so drawn from civil life, were sent to officers' training camps to become familiar with the fundamentals of Army discipline, organization and procedure, and everything possible was done to impart to the remaining officers who could not go to these training camps a similar knowledge.

These are the engineers who have officered our engineer combat organizations and who have executed the great work of construction in France, which in mere magnitude is at least equal to that done at home by the Construction Division, and which, in addition, has been executed under circumstances of far greater difficulty. To do this work in France it has been necessary to employ almost exclusively military organizations under the supervision of these engineer officers, so that practically the entire work has been that of men in uniform—soldiers, under close military control and discipline, whose operations were facilitated by the fact that those in authority over them were also soldiers, familiar with the necessity of military discipline and routine of administration.

This, then, is a point that I wish to emphasize—that certainly in the theater of war, where operations of construction must be performed by soldiers, it is of the highest importance that the engineers in charge shall be familiar with military procedure. In this manner alone can the work be conducted without undue friction and difficulty.

As the head of the engineer service of the American Expeditionary Forces, I have had a unique opportunity to come into contact with the leaders of our profession. Nothing that I can say would be adequate to express my admiration of the magnificent work that these men have done here in France, both in the combat organizations and in those more specially devoted to construction of various kinds. My experience with them has confirmed me in the belief that, professionally speaking, there is no real difference in training and attitude between the officers of the permanent Corps of Engineers and those of their professional brothers from the country at large who offered their services to the United States for the duration of the recent emergency. The education of officers of the permanent Corps of Engineers is conducted along sound engineering lines, and their normal experience in times of peace—namely, in the construction of works of seacoast fortification and of river and harbor improvement—involves the assembly, organization and use of the same instrumentalities as are employed by all engineers. Much of their work is done by force account, thereby adding breadth and value to their construction experience.

Feeling this to be true, it has been my deliberate policy here in France to make no distinction between those officers more recently drawn from civil life and the permanent engineer officers of the Army. I have endeavored to employ each man to the best national advantage, regardless of whether he came from civil life or from the Army. The results have proved that the country can, as it must, hereafter confidently rely upon the engineers of the United States, civilians, to furnish the large increase needed in time of war for the engineer work needed in the front line as well as along the line of communication; but, I am also convinced, it is a decided advantage to have these engineers enrolled in an Engineer Reserve Corps, the members of which are put in the closest possible touch with such details of military organization and administration as must exist in a well ordered Army. There must, of course, always be a corps of regular engineers, trained

and educated as indicated above, sufficiently large to take care of the necessary expansion, and to take charge of and prosecute all Government engineering and construction work in times of peace that may be confided to it.

In this way alone can proper coördination of effort and ultimate efficiency be secured, and it is to emphasize this important point that this letter is written. It would be, I think, extremely damaging to our country to permit the dissemination of a definite and widespread impression that for military purposes a civilian personnel, unfamiliar with and untrained in Army organization, administration and methods generally, is as serviceable as a force of corresponding productive capacity which has the added advantage of familiarity with necessary Army procedure. W. C. LANGFITT,

Major General, U. S. A., Chief Engineer, A. E. F.
France.

Latin and Greek for Engineers

Sir—The article by Dean Cooley quoted in your issue of May 8, 1919, p. 930, touches a very live subject. There is no doubt that engineering graduates are narrow in their viewpoint. But are they the only ones? If my observation is to be trusted, the same criticism can be made of almost all men taking technical and even purely scientific courses. In other words, it applies to men whose work deals with *things* rather than with *persons*. Perhaps there is a tendency for this aloofness of attitude to be more pronounced with engineers, since so much of their work involves moving about, and hence they do not feel the same interest in their neighbors that a man would who felt more securely settled in his community.

If my idea is correct, the remedy is to turn more attention to subjects dealing with persons—history, sociology, economics, literature, English, modern languages. So far I go with Dean Cooley. But as for Greek and Latin—I doubt the benefit.

I am inclined to think there are few engineering schools where the other subjects mentioned above are not taught and some of them, at least, required. But the engineering students do not get the benefit that arts students do. And this is the crucial point, in my opinion. There is a constant effort on the part of engineering students to get out of the little that is required. The universal term for all such studies seems to be "junk," and if they cannot be escaped as little is absorbed as it is possible to do and get by. The arts student recognizes that this work is an essential part of his training and studies accordingly.

To remedy the situation we must make the student of engineering take the same attitude. It is extremely difficult for the college to do it. The student regards the college authorities as prejudiced and as the victims of tradition. His home influences are very likely in the same direction; and I am of the opinion that the influence of many engineers is also. It will take many articles like that of Dean Cooley to counterbalance the remarks of Dr. Waddell on the study of Latin in the preface to "De Pontibus."

I hope it can be done. It will ease the path of the student adviser on the faculty. As it is, the man taking engineering wants engineering and nothing else, and the school must to a large extent meet his demand or lose the student. The acceptance of the obligation to train for good citizenship is connected with the acceptance of other obligations which are at variance with the popular philosophy that a man's prime duty is to get the most for himself and to ignore his duties to others.

I await with great interest further discussion of the article. FRANK H. CLUTZ, PH. D.,

Department of Civil Engineering, Pennsylvania College.
Gettysburg, Penn.

Credit for Original Design of the New Orleans Army Base

Sir—A protest is in order on a matter of professional etiquette regarding the article on the New Orleans Army base in *Engineering News-Record* of Apr. 24, 1919, p. 823. This group of buildings was originally laid out, with no reference to its use as an Army base, by the engineers of the Board of Commissioners of the Port of New Orleans, and the layout was used almost without modification. The original reinforced-concrete design was made by C. A. P. Turner, of Minneapolis, and was in accord with the Chicago building code; this design was used with only minor changes involving additions to the cost of the structure. Two of these warehouses will be given back to the supervision of the Board of Port Commissioners, and payment of the cost of construction required. It is of course right and proper that the State of Louisiana should bear a part of the increased cost of construction made necessary by the assumption of this work by Army engineers with their appropriate demand for speed above all other considerations; but credit for the whole should not have been assumed without stating the above mentioned facts. MARSHALL G. FINDLEY,

Designing Engineer, Board of Commissioners of the Port of New Orleans.
New Orleans, La.

[An inquiry regarding the facts recorded in the above letter addressed to George H. Davis, the author of the article in question, has been acknowledged by him as follows: EDITOR.]

Sir—I would acknowledge receipt of your letter, and note the communication which you have received from M. G. Findley making the point that the group of buildings was originally laid out, with no reference to its use as an Army base, by the engineers of the Board of Commissioners of the Port of New Orleans, and that the layout was used almost without modification. In reply I would say that on Aug. 15, 1918, you published an article on this development which included a perspective drawing showing the group of buildings in question and the New Orleans ship canal and terminal, as indicated, with accompanying maps and sketches. In this article it is mentioned on p. 306 that at the Mississippi River entrance of the canal commodity warehouses shown in perspective have just been started and have been taken over by the United States Government for use as quartermaster's stores. It is also mentioned at this point that the construction is being carried on under force account by the Board of Commissioners of the Port of New Orleans, of which W. B. Thompson is president and J. Devereux O'Reilly is chief engineer. On July 26, 1918, the firm of Ford, Bacon & Davis was appointed supervising engineers by the construction division of the Quartermaster Corps of the United States Army, and since that time the design and construction of the plant have been in charge of the

organization, as indicated by me in the article of Apr. 24, 1919, p. 826, to the exclusion of the Board of Commissioners of the Port of New Orleans or the engineers or other officers of the board. As to their previous connection, I am of the opinion that the article of Aug. 15, 1918, gave the Board of Commissioners of the Port of New Orleans and its engineers full publicity.

New Orleans, La. GEORGE H. DAVIS.

Definite Specification for Overhaul

Sir—The definition of "overhaul" and specification for payment are not easily made. The attempt described in your issue of Apr. 24, 1919, p. 835, is evidence sufficient.

The writer several years ago prepared the following definition and specification covering overhaul on canal earthwork. He believes it is readily understood by anyone familiar with this class of construction, and leaves no opportunity for misinterpretation.

"*Haul*—For all haul beyond the length of free haul overhaul shall be paid. The measure of overhaul shall be the 'station yard,' which shall be the hauling of one cubic yard one engineer's station, or 100 lin.ft. The amount of overhaul in any case shall be computed by determining the number of engineer's stations intervening between the center of mass of overhaul yardage as it lies in excavation and as it lies in embankment, deducting therefrom the length of free haul, in engineer's stations, and multiplying the remainder by the yardage of overhaul." EVERETT N. BRYAN.

Waterford, Calif.

Capital, Labor and the Engineer

Sir—In your issue of Apr. 24, 1919, p. 834, you print a letter from Thomas P. Morrissey in which he calls attention to the lack of understanding between labor and the professional engineer. He says the engineer "has seen fit to act as go-between" for capital and labor, and has "considered capital as his client."

In the first two ideas Mr. Morrissey is wrong. In the third he is right. At the beginning of work requiring engineering assistance the owner, generally the capitalist, starts an engineer on the work of preparing the plans. Thus, at the outset the engineer reaches an understanding with the capitalist. The engineer looks to the capitalist for employment, and not to labor. If the work requires execution the engineer is placed in charge and may then have some dealings with labor.

The engineer has never seen fit to act as go-between, and would not relish such a position, though he is sometimes half-way between. Capital and labor reach their agreements without the assistance of engineers. But the engineer often finds himself acting as buffer between two opposing forces. Sometimes these forces are a contractor and an owner, and sometimes they are a capitalist and a laboring class. From the nature of the engineering business this buffer position cannot be avoided.

On contract work which is done under the supervision of engineers, the engineers make the mistake of accepting employment direct from the owner. If the engineers would insist that the contractor have equal voice with the owner in the selection and payment of the engineer, there would be a certainty that the engineer would hold himself as much responsible to the one as to the other, and place himself above the suspicion of favoring any side of a transaction of which he is supposed to be an impartial judge. F. T. HOWES.

Member, American Association of Engineers.

Emigrant, Mont.

Build the Road to Fit the Traffic

Sir—Economy in highway transportation is far-reaching in its results, benefiting not only the users of the highway but the producers and the final recipients of the goods transported. For this basic reason, everything which, directly or indirectly, tends to lower the cost of highway transportation is of immediate interest to the public, which in the end pays the bills. The greatest economy in transportation can only be attained from a general application of systematic, continuous, organized effort directed along practical lines.

Such practical lines can only be determined by a complete recognition of all the factors involved in highway transportation and by a thorough study of their relations to one another and to the end sought. For such a study, much data must yet be secured and correlated.

One line of information needed for all the main traveled roads of this country is that of the kind, weight and amount of daily traffic passing over them. This traffic factor bears upon the selection of routes, establishment of grades, width of roadways, strength of bridges and culverts, type of pavement and cost of maintenance. A traffic census is needed *now*, before extensive and costly improvements are undertaken, in order that a more rational development may follow and the greatest economy be secured. The various highway commissions in this country could well devote some attention and funds to this important basic work and thereby lay the foundation for securing roads designed and built to fit the traffic. Every highway engineer, every highway commissioner, every good-roads advocate, every automobile and motor-truck association, every good-roads organization could well afford to adopt the slogan, *"Build the road to fit the traffic."*

Kansas City, Mo. ROBERT C. BARNETT.

Wireless Telephone Outfits for Surveying and Construction Operations

Sir—The war witnessed the development of the wireless telephone from the experimental stage to that of a practical and usable field outfit. It has occurred to the writer that the portable wireless outfit, as used by the Signal Corps Field Service, U. S. A., will be a very useful adjunct to the equipment in many engineering operations.

The portable equipment consists only of two cases, containing the batteries and transmitting and receiving apparatus. The antennæ may be mounted on natural objects, or on two light 15-ft. poles included with the outfit, which serve as supports. These outfits usually have a range of from 5 to 20 miles. This equipment should prove useful to a water-works department, the engineer engaged in surveying, or to the construction engineer in conjunction with work covering considerable territory, such as construction of canals, pipe lines and railroads.

The writer once used six of these outfits in a survey

of base lines for triangulation in the Army meteorological and aërological work. Six different parties were distributed on this survey, and throughout the entire work were in constant communication with one another, although miles apart in rough and rugged country. The use of the wireless outfit so expedited the work in hand by permitting the six different parties to work in harmony with one another, when other means of visual signalling or wireless communication was impossible, that the survey, which otherwise would have taken a week or ten days, was finished in a single day.

Now that the war is over, these outfits will soon be on the market and engineers should not be slow in adapting them to civilian enterprises.

Albany, N. Y. FLOYD A. NAGLER.

Distortional Rotation and the Principle of Virtual Work

Sir—Referring to the article on finding the rotation of a member in a truss or at any point of a beam under stress, given in your issue of May 1, 1919, p. 864, it does not seem quite right to say that there is a new principle underlying the method presented. It was taught to the writer and its results pointed out, about 25 years ago, and in the last edition of "Modern Framed Structures" the problem is taken up and solved.

Aside from this, it seems to me that all similar questions about linear or angular elastic changes, as well as indeterminate stresses, are much more comprehensively treated by using the law of virtual work. Take for instance the bent beam, mentioned in the article:

If certain loads P and external moments M are applied to it and if, furthermore, any arbitrary deflections d are assumed to take place at the loads P and in the direction of the same, and any arbitrary rotations v at the external moments M, then the external virtual work done is:

$$\Sigma\, Pd + \Sigma\, Mv$$

This work shall now balance the work of the internal stresses. If the moment in any section caused by the loads P and the external moments M is called M_t and the moment in the same section corresponding to d and v is called M_s, the internal virtual work is

$$\int \frac{M_t\, M_s\, dx}{E\, I}$$

The equation

$$\Sigma\, Pd + \Sigma\, Mv = \int \frac{M_t\, M_s\, dx}{E\, I}$$

gives us immediately a means of finding either any rotation v or any deflection d. As P and M can be given any values we see fit to select, we may put every $P = O$, also every $M = O$ except at the point whose rotation is wanted, where we put $M = 1$ and get:

$$v = \int \frac{M_t'\, M_s\, dx}{E\, I}$$

By analogous assumptions we also get:

$$d = \int \frac{M_t''\, M_s\, dx}{E\, I}$$

The only difference is that M'_t in the first case represents the internal moment due to a unit external moment applied where v is wanted, and in the second case M''_t represents the internal moment due to a unit load where d is wanted. In either case M_s may represent the actual moment corresponding to v or d, as in your article.

It is apparent that if either M_t or M_s is equal to zero for any particular portion of the beam, the summation need not be extended over that portion, as it evidently does not have any effect on the elastic change.

Chicago, Ill. GEORGE N. LINDAY.

A Definition of Professional Engineering

Sir—The license committee of Engineering Council, in its study of laws adopted, or proposed, for licensing engineers in various states and in Canada, is considering one of the most puzzling details—to evolve a definition of professional engineering practice. The following definition has been arrived at after very careful study:

> The practice of professional engineering embraces designing and responsible supervision of the construction, operation or maintenance of private or public utilities or works, and designing or responsible supervision of processes of production, means of transportation and methods for the disposal of waste, when such designs or supervision involve and require the intelligent application of the principles of physics, mechanics, hydraulics or thermodynamics in the determination of the proper selection, use, removal or disposition of material for the attainment of a definite purpose.

The writer would be glad to have you print this definition and equally glad to receive from any of your readers comments or suggestions for its improvement, bearing in mind that brevity and clearness are all-important. Many of the definitions in the laws examined are very lengthy in detail, but, nevertheless, fail to define professional engineering adequately.

T. L. CONDRON,
Chairman License Committee, Engineering Council.
Chicago, Ill.

A Resource That Every Engineer Should Know

Sir—Let me recommend to all your readers that the headquarters of the American Library Association should be appealed to generally as a clearing house of information. If an engineer has a question that puzzles him and he does not live in a large city, with access to a good technical reference library, he should send his question to the American Library Association, 78 E. Washington St., Chicago.

Whether or not such appeal meets with due response, I should be glad to know the result, as I have long been working for a closer connection between the library industry and other industries. Experience with information bureaus has convinced me that there is great need to establish a public demand for information, for already there exist great facilities of which the public has hardly begun to avail itself. Moreover, my familiarity with the American Library Association enables me to say with confidence: Here is an organization having enormous research possibilities, which need only to be used in order to develop a large service that has long been latent.

I made the foregoing suggestion in a paper that was sent to a convention of chemists in Buffalo this spring, and so far three or four have acted upon it. The *Library Journal* for May published for me an article entitled "The Library Phalanx, a Presidential Address at a Phantom Convention." I believe this article would appeal to many who are interested in the general subject

of getting at information and to many who have been bewildered by the difficulties of getting as much out of a convention as they had hoped for. I shall be glad to send reprints of this article, upon request.

G. W. LEE,
Librarian, Stone & Webster.

147 Milk St., Boston, Mass.

Subdrainage for Country Highways

Sir—Referring to W. P. Blair's article in *Engineering News-Record* of May 8, 1919, p. 914, and your editorial calling attention to some objections to subdrainage for highways: The writer has had many years' experience in planning and superintending drainage for highway, municipal and agricultural purposes, and has observed carefully the effect of subdrainage upon highways.

Many times, in constructing underdrains for agricultural purposes, farmers will take advantage of the highway side ditch in order to save depth in placing their outlets, often running some distance along the side of the highway. My observation has been, and the testimony of road superintendents is, that roadbeds where drains have been so placed settle much earlier in the spring and cost much less for maintenance.

A number of years ago, in constructing a gravel road, the writer placed a line of farm tile on each side, 8 ft. from the center line. In this case the outlets were not as good as they should have been, but the reports of the superintendent of roads show a much lower cost of maintenance than for similarly constructed roads without the drains. Residents along the line also state that this road settles and is ready for heavy traffic much earlier than the others.

The action of subdrainage is twofold: Removing excess water, and aëration of the soil.

This brings us to some objections mentioned in your editorial on the question of how to arrange for drainage of subsoils which are practically waterproof, such as clay. Where or when in the springtime did any contractor or engineer outside of arid regions find any clay that was not saturated with water? If it is waterlogged it must be porous; if there are pores the air can enter when the water is withdrawn. And therein lies the advantage of subdrainage. The removal of water from the subsoil permits the entrance of the air, and in flowing out, the water makes way for the small current of air which must flow in to take its place. This action places the soil in such condition that the moment excess moisture appears it begins to sink toward the tile instead of lying in the ground, which becomes saturated until the water is removed by evaporation. Subdrainage allows the grade to solidify much earlier and more quickly than when water stands in level side ditches and soaks into the grade. In cuts, subdrainage is especially advantageous, as it prevents ground water from the banks from reaching the subgrade.

Except in extreme cases, the writer would not regard the laterals shown in Mr. Blair's plan as necessary. In most soils the action of the subdrain will have its effect much farther than half the distance shown in his plan, and, when the subgrade is once drained and the hard surface road constructed, but little, if any, water will reach it.

Where highways are being reconstructed—that is, being changed from gravel or macadam to hard surface—through a well underdrained farming country, subdrains along the highway would be required in but few places.

As to the tile filling with roots, in the case of country highways this likelihood would be negligible, the occasional shade tree not being likely to have roots of the water-seeking variety, and, should such trees exist, the removal of the cause is a small matter.

The matter of subdrainage as an aid to maintenance is also neglected by the railroads, by which large sums could be saved by a small expenditure for such work. My experience has been that subdrainage is a benefit to any roadbed, making even the dirt road easier to maintain and better for travel. M. H. DOWNEY.

Anderson, Ind.

[It should be noted that Mr. Downey has treated the problem largely from the standpoint of the rapidity with which saturated roadbeds dry out in the spring, rather than from the standpoint of maintaining dryness, which we understand to be the end sought by Mr. Blair. It is admitted that dry clay soil is hard to find in the spring. This is not only the case under earth and gravel roads, but also under hard surface roads. How to keep capillary water from collecting under the road surfacing and causing frost heavage in the winter is the problem to be met by the engineer. When the roadbed is saturated the damage is done. That roots are a problem in some sections, at least, is shown by inquiries that we receive as to how to prevent such clogging of the tile.—EDITOR.]

Suggestion for Geological Survey Maps

Sir—I learn from your editorial in the issue of Apr. 17 that an effort is being made to popularize the Geological Survey maps by making the contours more understandable to the general public through the use of colors.

I made an experiment of this kind a few months ago that may be of interest. I had a comparatively large map of a rough region in which a drainage project, a highway and a number of bridges were planned, which improvements it is proposed to finance by a municipal bond issue. For explaining the project to the public I desired to put the map in such form as would make the contours understandable to those unfamilar with such maps.

As the portion of the map desired to be brought out had a range of grades of 105 ft., represented by contours at 5 ft. intervals, 21 in all, I selected a complete spectrum chart of 21 shades of colors and had each of the contour lines colored to match one of the colors of the spectrum chart. I had the lowest grade colored a deep violet and each of the succeeding contours colored the successive spectrum shades, the highest contour line being red.

The resulting map brought out the differences in elevation in a remarkable way, except that the blue colors were largely lost, owing to the fact that the lines of the print itself were blue. If the colors had been put on a perfectly white paper and a slide of it made by the Lumière, or other color-photography process, it would probably have produced the effect desired.

The Geological Survey bureau probably has considered such a method, but if not may find it worth trying. Only when the maps are to be engraved, however, would it be possible to reproduce them without very great expense. L. R. BOWEN,

Engineer of Bridges and Buildings, City of St. Louis.

St. Louis, Mo.

HINTS FOR THE CONTRACTOR

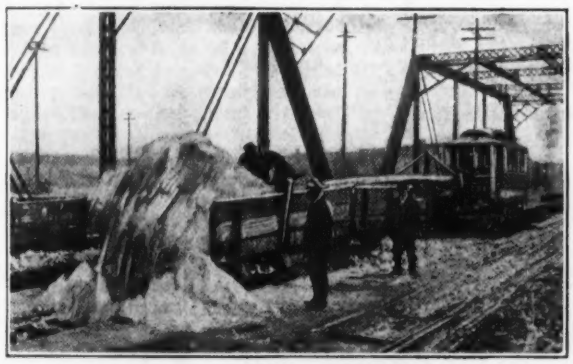
DETAILS WHICH SAVE TIME AND LABOR ON CONSTRUCTION WORK

Push Plow Unloads Flat-Cars

FOR unloading dirt from flat-cars a mechanical pusher or plow has been devised and built by the Denver Tramway Co. On a four-wheel truck is mounted the heel of a 55-ft. horizontal pole which carries a rectangular steel plate on the projecting end and is made rigid by means of three truss rods. On the rear end of the truck are piled old car wheels to form a counterweight.

This pusher stands on a siding at the dump. When a loaded car has been placed for unloading, the brakes are set and the side boards are lowered. The motor car then runs back and is coupled to the rear of the pusher car, which it drives forward until the plate on the pole has pushed the load off the floor of the flat-car. The brakeman stands behind the plate and guides it so that the entire floor of the car will be cleared.

In the description of this device by W. L. Whitlock in the *Electric Railway Journal* of May 10, 1919, p. 924,



PUSHER REMOVING SNOW FROM FLAT-CARS

it is stated that two men—conductor and brakeman—can unload a dirt car in about 15 min. In unloading snow, three men with the pusher were able to do the work of 15 shovelers, with an average of 6 min. per carload of 12 to 14 cu.yd. of snow.

Other Articles in This Issue of Interest to Contractors:

How One Contractor Went About a Housing Job	Page 1044
Motor Equipment of United States Army Engineer Corps	Page 1052
Daily Code Letter Shows Status of All Highway Work	Page 1060
Maintaining Traffic During Erection of Louisville Bridge	Page 1061

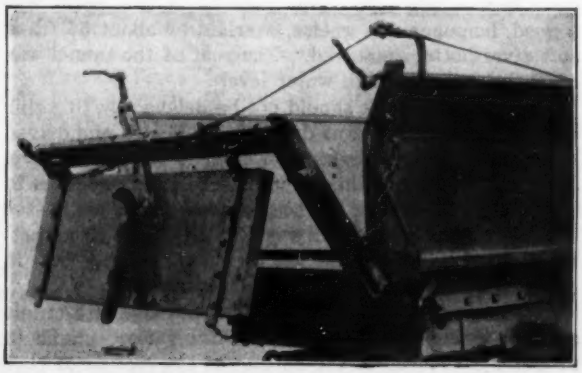
Gin-Pole Removes Train-Shed Trusses

REMOVAL of a steel train-shed roof without interference with traffic was carried out successfully by the Indianapolis Union Ry. in connection with the reconstruction of the union station. The framing consisted of trusses of 102-ft. and 68-ft. span, spaced 26 ft. to 45 ft. on centers and supported on steel columns. After the roofing had been stripped, each truss in turn was cut away near the ends by means of oxyhydrogen torches, the middle portion being handled by a gin-pole derrick having a 60-ft. pole guyed by cables and having its rope led to a hoisting engine placed on one of the platforms. As soon as the truss was cut and swung clear it was turned parallel with the tracks and lowered to the ground. This work had to be done in intervals between trains, and the method adopted eliminated the necessity of occupying the tracks by cranes or other machinery. The portable derrick could be quickly set up and guyed and as promptly removed to clear the tracks. The steel columns with the ends of the trusses attached were released from the footings and pulled over in a direction parallel with the tracks by men hauling on tackle hitched to the top of the column. The lowered trusses and columns were then loaded onto flat-cars by a railway wrecking crane and transported to their destination. By these methods interference with trains was entirely avoided.

Combination Detachable Truck-Body Serves Several Purposes

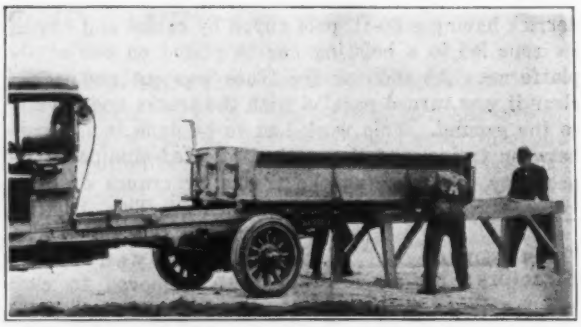
A MOTOR truck with a removable combination express and dump-delivery body has recently been delivered to Charles S. Wheeler of McCloud, Calif., by the Federal Motor-Truck Co. Express and other commodities can be hauled in the box, or sand, gravel, etc., can be hauled and dumped. The box being removed, heavy and cumbersome material such as logs, etc., can be hauled about Mr. Wheeler's estate.

The construction of the truck and the manner of manipulation are shown in the photographs. The tailboard is arranged with hinges at both top and bottom so that it will lie flat for loading merchandise, or open at the bottom for dumping sand and gravel. By releasing the hoist cables which are bolted to the front of the truck and removing the swivel bolts from the



DOUBLE-HINGED END BOARD LIES FLAT OR DUMPS

box hinges at the back, two men can roll the body from the truck frame, which is equipped with rollers, to the roller platform, as shown. This operation takes less than 4 min. The rollers on the frame are also advantageous for loading heavy material when the truck is



REMOVING BOX FROM ROLLER FRAME TO PLATFORM

used without the box. The hoist cables are arranged for drawing heavy materials upon the frame. The truck was especially designed to meet the requirements of Mr. Wheeler.

Subaqueous Tunnel Heading Under Eight Inches of Rock Cover

By Alexander Lyle
Field Engineer, Booth & Flinn, Ltd., New York City

By careful judgment in blasting, an interesting and difficult piece of tunneling was recently carried out successfully in one of the west headings of the new 14th St. rapid-transit tunnel under the East River, New York City. When the heading, which was advancing in full-rock face, without compressed air, approached a depression in the surface of the rock, the test holes that are drilled before each shot indicated that the rock cover was becoming exceedingly thin. Ultimately the rock proved to be only 8 in. thick over the top of the arch, at the lowest point of the depression. The question was how to proceed with the rock work under these conditions.

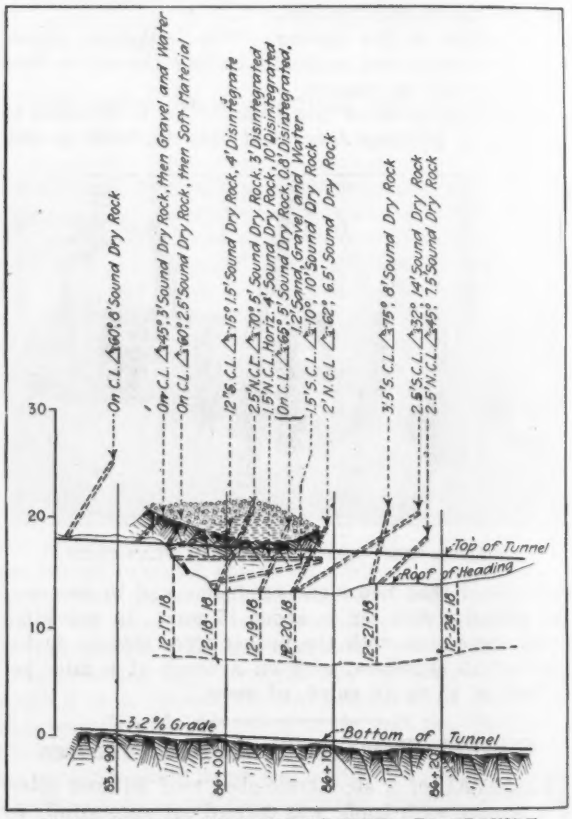
Here was a free-air rock tunnel 17 ft. 2 in. in diameter, with the roof to be trimmed to within 8 in. of the rock surface. The risk involved was that the river bottom might be brought in if the thin shell of rock were broken through. The material at this point was a good, homogeneous gneiss, overlaid by about 56 ft. of soft river-bottom material. The roof of the tunnel was 83 ft. below mean high-water level

In order that work should not be delayed by this thin spot, the top heading was dropped about 4 ft. and driven ahead until the test holes showed that the proper level could be resumed. This bypassing allowed progress to be maintained. After the heading and bench had passed out of shooting distance it was decided to carry the cast iron tunnel lining beyond the thin point of the roof, in order to insure the safety of the heading.

As the first step in preparation, the concrete cradle and the bottom segments of iron lining were placed in proper position, up to the bottom of the section of roof that required trimming; this work involved no particular difficulty. The flanges of the lining were then well protected with timber, to avoid breakage when it was hit by falling pieces of rock.

At first the plug-and-feather method was considered for trimming the depressed section of roof to the neat line. This method was rejected as too slow, however, and it was decided to try very careful blasting. The results showed the blasting method to be entirely safe and successful. Short trim holes were drilled, loaded and shot, to take out the rock to within a foot of the desired excavation line, for a length of tunnel just sufficient to clear the ring of lining next to be erected. Additional trim holes were then drilled just on the neat line. These holes were spaced about 6 in. apart, and were loaded with about one-eighth stick of dynamite, sometimes every hole but usually only every other hole. Shooting these holes, one by one, took out the arch excavation very close to the neat line, and only rarely required a little hand-trimming in order to allow the iron lining to be placed. The blasting being very light, and the rock weakened by the closely spaced holes, no damage was done to the remaining cover.

As soon as space was cleared for the erection of one plate of lining, the plate was erected and all spaces back of it were filled by driving in rock packing. Operations were then transferred to the opposite side of the tunnel, and clearance was made for another plate. The work


On C.L. Δ60° 6' Sound Dry Rock
On C.L. Δ45° 3' Sound Dry Rock, then Gravel and Water
On C.L. Δ60° 2.5' Sound Dry Rock, then Soft Material
12' S. C.L. Δ-15°; 1.5' Sound Dry Rock, 4' Disintegrate
2.5' N.C.L. Δ 70°; 5' Sound Dry Rock, 3' Disintegrated
1.5' N.C.L. Horiz.; 4' Sound Dry Rock, 10' Disintegrated
On C.L. Δ65°; 5' Sound Dry Rock, 0.8' Disintegrated, 1.2' Sand, Gravel and Water
1.5' S.C.L. Δ 10°; 10' Sound Dry Rock
2' N.C.L. Δ 62°; 6.5' Sound Dry Rock
3.5' S.C.L. Δ 75°; 8' Sound Dry Rock
2.5' S.C.L. Δ 32°; 14' Sound Dry Rock
2.5' N.C.L. Δ 45°; 7.5' Sound Dry Rock
30
20
10
0
Top of Tunnel
Roof of Heading
12-17-18
12-18-18
12-19-18
12-20-18
12-21-18
12-24-18
-3.2% Grade
Bottom of Tunnel
55+90
56+00
56+10
56+20

SECTION WITH HEADING DROPPED TO PROVIDE SUFFICIENT ROOF THICKNESS FOR SAFETY

thus continued one plate at a time until the entire ring had been completed, and then shifted ahead to the next ring. Booth & Flinn, Ltd., are contractors for this tunnel. M. L. Quinn is their general superintendent, and Sam Allen is shaft superintendent. M. H. Freeman supervises the work for the Public Service Commission.

NEWS OF THE WEEK

New York, May 29, 1919

Sees No Price Reduction in Building Material

Report of Illinois Joint Legislative Commission Recommends State Operation of Plants

Acting under a joint resolution of the legislature of Illinois, a legislative committee has just completed an investigation into the cost of building materials. The commission held a number of public hearings, but confined its attention to the price conditions in brick, cement and lumber. It reported that the costs of brick do not seem to be unduly high, and that there is no evidence of illegal combinations to regulate the price of common building brick. The committee's report on lumber is quite ambiguous. The intimation is that it does not consider the price too high, but no definite statement is made.

In its study of cement it seems to feel that the prices are too high. The committee states, for instance, that a Government expert asserts that the manufacturing cost of portland cement in a 3000-barrel mill should be $1.25 a barrel, as against an actual cost figure submitted by a cement company of $1.67 per barrel. It says that it could find no positive evidence of combination of cement manufacturers to establish prices, but that the "circumstances indicate that cement prices are fixed by agreement." The committee also states that the La Salle Portland Cement Co. had net earnings from operations of over 77½% on its capital stock, but gives no figures as to the relation of the capital stock to the net investment.

The committee recommends that the interests of the state are so great that it believes the state should engage in the manufacture of cement for public works, as this would have a tendency not only to create competition but would serve to keep the public constantly advised as to the cost of production of the product. As a final conclusion, the committee thinks that prices are at a new level, and quotes approvingly the widespread statement of Prof. Irving Fisher. As a result of the investigation, it is recommended that the state, as trustee for the people, should protect the public from extortionate charges for roadbuilding material, and should be authorized to manufacture products entering into the public improvements of the state. The committee therefore recommends the passage of an act enabling the state to acquire land, mines, quarries, mineral deposits, etc., necessary for raw material, and to lease them, to sell and dispose of products, to enter into contracts with producers for the supply to the state of the raw materials, to extend loans to the manufacturers of such materials, and to permit competition in patented roadbuilding products.

Employment Bureaus

Engineering Societies' Employment Bureau, 29 W. 39th St., New York City.

American Association of Engineers, 29 S. La Salle St., Chicago. Service to members only, but Army or Navy Engineers in uniform who are eligible to certified membership may join without payment of entrance fees or dues while in uniform and for six months after discharge.

Engineers' Service Bureau, 57 Post St., San Francisco. Only applications by mail or wire will be considered.

Professional and Special Section, United States Employment Service, 469 Fifth Ave., New York City.

Reëmployment Committee of New York City for Soldiers, Sailors and Marines, 233 Broadway, New York City.

Transit Construction Commissionership Declined by Engineers

With the appointment of John H. Delaney as Rapid Transit Construction Commissioner for New York City, Governor Smith of New York State announces that the position had been declined by Col. William Barclay Parsons, consulting engineer, and by J. Waldo Smith, chief engineer of the Board of Water Supply. Mr. Delaney has until now been the city's Commissioner of Plant and Structures, having charge of bridges and ferries.

Government To Build River Boats

Contracts for boats to be used in the freight traffic on the Warrior River under Federal direction have been let by the United States Railroad Administration, Inland Waterways Division. The St. Louis Boat & Engineering Co., of St. Louis, Mo., is to build four steel, self-propelled tunnel-type boats, for $244,400 each; the Howard Shipyard & Dock Co., of Jeffersonville, Ind., has the contract for three steel towboats of the twin-screw tunnel type for $137,000 each, and the Murnan Shipbuilding Corporation, of Mobile, Ala., will build the 20 wooden barges for $5985 each. Delivery of the steel boats is to be commenced next August.

Federal Highway Commission Opposed by Houston

Secretary of Agriculture Defends Present System—Explains Objection to New Plan

In response to a communication from a city chamber of commerce requesting the views of Secretary of Agriculture Houston regarding the creation of a Federal highway commission and the wisdom of taking the Federal supervision of roads from the Department of Agriculture, Mr. Houston has made a detailed reply. He opposes the commission idea which has been indorsed by chambers of commerce and other organizations throughout the country, and defends the present system. The arguments which are advanced by Secretary Houston are as follows:

Before the advisability of changing the present methods of administering the national highway funds are considered, there are certain facts that it is well to have in mind. First, the importance of roads and the traffic conditions vary throughout the country; second, the state highway departments, being in immediate touch with the situations in their respective localities, are best able to classify and judge which roads will serve the greatest economic needs, and, thirdly, the Federal Government is now aiding the states in considering their technical problems in the selection and improvement of the most important roads, and, when the state department has properly selected a state highway, it generally meets a state highway in an adjoining state and the two become an interstate highway of nation-wide utility.

Furthermore, there is already in existence an excellent organization, the Bureau of Public Roads, which works in a coöperative manner through the 48 state highway departments, under the provisions of the Bankhead Federal-aid road act.

Ample funds have been provided by Congress, the law has been amended to made it work more smoothly, and provision has been made by increasing the Federal allowance per mile, so that roads of substantial character can be built. Altogether, there seems no obstacle in the way, now that the war is over, of the building of those roads which will serve the greatest economic needs.

With the above conditions in mind, the secretary finds it difficult to see what need there is for additional machinery, such as would be required by a Federal highway commission, or, as suggested in a bill introduced in the

last Congress [the Townsend bill, described in *Engineering News-Record* of Feb. 7, 1919, p. 446], which would commit or limit the Federal Government to the construction of two Federally owned and maintained trunk lines in each state.

After calling attention to the fact that there is now in the Federal treasury about $300,000,000 available for roadbuilding, Secretary Houston suggested that it is unlikely that Congress will appropriate additional funds for this purpose, under present financial conditions. He also pointed out the difficulty in diverting the money pledged, from the present appropriations, from the projects for which it has been laid aside, as would be necessary to put the commission plan into effect without further appropriations.

Another problem would be the necessity of changing all the state highway laws, some of which were passed with difficult to meet the new plan. It is doubtful that the states would be willing to change from the present plan of developing the roads serving the greatest economic need to a plan for building two main trunk lines in each state.

Conference on Federal Road Laws Held in Washington

Federal highway legislation was discussed at a conference in Washington on May 20 called by Senator Townsend, author of the Townsend highway bill, for officials of various states and members of the Highway Industries Association. The meeting was attended by representatives from all parts of the country and it is reported that sentiment was very strong for a comprehensive national highway policy along the lines suggested in the Townsend bill. [See *Engineering News-Record* of Feb. 27, 1919, p. 446.]

Among those present were A. R. Hirst, state highway engineer of Wisconsin and president of the American Association of State Highway Officials; G. P. Coleman, state highway commissioner of Virginia and chairman of the executive committee of the organization; Paul D. Sargent, chief engineer of the Maine State Highway Commission; Col. W. D. Uhler, chief engineer of the Pennsylvania State Highway Department; M. L. Cunningham, state highway engineer of Oklahoma; W. S. Keller, state highway engineer of Alabama; Ira R. Browning, state road engineer of Utah; S. M. Williams, president, and H. G. Shirley, secretary, of the Highways Industries Association.

State Buys Two Toll Bridges

State purchase of the Greenbush bridge at Albany and the Congress St. bridge at Troy is provided for by two bills of the legislature recently signed by Governor Smith of New York. Sums amounting to $1,700,000 are made available for the purpose. Tolls collection on the bridges will be abolished.

Sixth Canadian Good Roads Congress and Exhibit

Good Attendance Reported—Resolutions Favoring Federal Aid and Lower Freight Rates Passed

The Sixth Canadian Good Roads Congress and Exhibition, held at the Parliament Buildings, Quebec City, May 20-22, is reported to have been the most successful in the annals of the Canadian Good Roads Association. It started with a motor ride over 180 miles of improved road from Montreal to Quebec. More than 200 delegates were present, and the meetings were well attended.

Keen interest was shown in both the practical and theoretical addresses and papers. The program included addresses on many types of pavement, their construction and maintenance, and on road machinery. The only criticism made of the program was that it was rather overbalanced, the length of the papers curtailing too much the time for discussion. The most interesting exhibit was that made by the Ontario Highway Department, showing models of roads from Roman times down to the present.

The general tenor of the congress is indicated by the resolutions passed at the business meeting: The first petitions the Government, the Board of Railway Commissioners and the railways of Canada for a decrease of 10c. per ton on roadbuilding materials immediately, with an investigation to determine the possibility of a further reduction to a pre-war basis.

The resolution further points out that these rates in Canada have always been higher than in the United States.

Another resolution, dealing with Federal aid, was next passed, as follows:

"Whereas, the Canadian Good Roads Association has heard with the greatest satisfaction that the Dominion Government is contemplating the introduction of legislation with a view of granting financial aid to the provinces toward road improvements;

"And whereas, this association considers that such action would be a highly deserved appreciation of the efforts already put forward by the provinces in this connection and a much needed encouragement to their desire to endow the country with a first-class system of good roads;

"Therefore, be it resolved, that the Canadian Good Roads Association heartily endorses the principle, and strongly urges that it be carried through with the least delay possible."

A general resolution was passed urging the Dominion Government to proceed with any projected bridges affecting international or interprovincial traffic.

The following officers were elected: Honorary president, W. A. Campbell, Dominion Commissioner of Roads; president, S. L. Squire, honorary president of the Ontario Good Roads Association, Toronto, Ont.; first vice president, A. F. MacCallum, commissioner of works, Ottawa, Ont.; second vice president, Dr. E. M. Desaulniers, M.L.A., deputy speaker of the provincial legislature, St. Lambert, P. Q.; secretary-treasurer, George A. McNamee, of Montreal.

New York Governor Signs Bills Affecting Road Contracts

Two bills affecting road contractors have been signed by Governor Smith of New York. One deals with the cancellation of highway contracts made before the war, while the other pertains to the amounts of certified checks to be deposited with bids, and provides conditions whereby bonds for the completion of contracts may be omitted.

The first bill authorizes the termination of highway contracts entered into prior to Apr. 6, 1917, confers jurisdiction upon the Court of Claims to hear claims, determine the extra cost of work due to war conditions, and make awards for increased cost incurred.

The second law provides that all bids on highway contracts shall be accompanied by a draft or certified check for 3% of the amount of the gross bid. This check will be returned when the contract is executed and bonds are provided. The commissioner may, on request of the contractor, dispense with the giving of his bond, in which case 20% of the contract price will be retained until the work is completed.

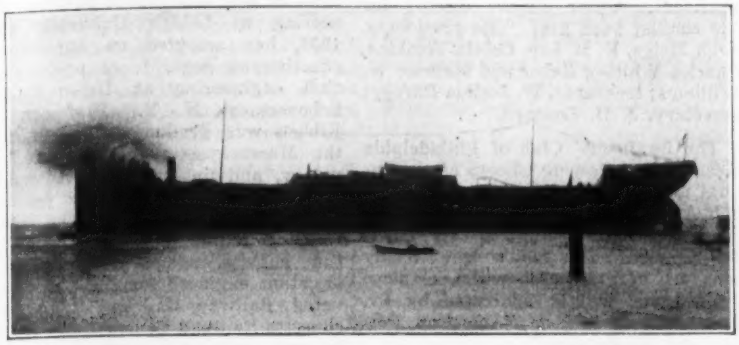
Septic Tank Patent Claims May Be Settled for Nominal Sum

Settlement of any and all claims of the Cameron Septic Tank Co., Chicago, for alleged infringements of the patents held by the company is provided for in a contract made between the company and the National Septic Process Protective League, Frank G. Pierce, secretary, Marshalltown, Iowa. The company agrees, for the sum of $5000, paid by Sept. 1, 1919, to release from all claims all who may be members of the league on the date named. The agreement also provides for dismissal of the suit brought by the company against Shelbyville, Ky., without cost to either party. The league, through its executive committee, has adopted a schedule of payments to be made by present members of the league or any who may join between now and Sept. 1, 1919, in order to obtain releases under the contract.

Detailed information may be obtained by addressing Mr. Pierce. The attorney for the league has advised that, although he is confident of winning the Shelbyville suit through a decision, and that the American patent expired with the British patent on Nov. 8, 1909, yet that since the cost of the settlement will be so much less than the cost of the litigation, it is advisable to accept the terms of the agreement. The league needs about $10,000 to meet the $5000 payment and all expenses. Any user of a septic tank is eligible to membership in the league and to release from royalty claims.

Third American Concrete Ship Launched

On May 22 the third American concrete ship, and the second to be built by the United States Government, was launched at the yard of the Fougner Concrete Shipbuilding Co., on Flushing Bay, Long Island. The ship, which was christened the "Polias," was described in *Engineering News-Record* of Dec. 12, 1918, p. 1058. It is a 3500-ton vessel, 281 ft. 9 in. long, of 46 ft. beam, and 26½ ft. molded depth. It was designed by the Fougner company and the construction was superintended by the concrete ship section of the Emergency Fleet Corporation. The vessel was stern-launched from the concrete ways and slid off into the water easily and successfully. Four days after launching it was reported to be bone-dry inside, there not being any evidence whatever of leaks or porous percolation. It has been ready for launching for some months, but it has not been possible to put it into the water on account of lack of depth of the offshore basin.



"POLIAS," 3500-TON CONCRETE SHIP, JUST AFTER BEING LAUNCHED

Choose Site for Pittsburgh South Hills Tunnel

A decision reached May 23 by the Allegheny County commissioners, jointly with the county planning committee, fixes the location of the South Hills tunnel, Pittsburgh, soon to be built. A high-level route has been selected, in contrast with the low-level locations of some earlier projects utilizing the Smithfield St. bridge as an approach. The new project provides for a tunnel extending from the Bell House on West Liberty Ave. to the Knox School on Brownsville Ave., and for a bridge over the Monongahela River to Sixth and Forbes Sts. The name "Liberty Tunnel" has been adopted for the entire improvement.

E. K. Morse, consulting engineer to the county, and W. M. Donley, engineer for the planning commission, directed the studies which resulted in the decision that this location will give best service to both the city and the South Hills district. On the question of ventilation, Maj. Gen. George W. Goethals, who was called in consultation, advised that no difficulty would be encountered in keeping the tunnel atmosphere in good condition.

The tunnel will be 5500 ft. long, and will have a single opening 44 ft. wide. Its grade will be 2%. It will serve pedestrian as well as street-car and roadway traffic. A branch tunnel 1000 ft. long to reach Hagerman Ave. is also being considered.

Colorado Engineers Form Engineering Council

At a meeting in Denver, May 16, representatives of eight organizations of the state met and formally launched the Colorado Engineering Council in order, according to its constitution, "to coördinate the work of various technical, scientific, and engineering organizations, promote the welfare and professional standing of their members and foster a more general recognition of the engineer in civil matters." Among the associations represented were the Colorado Scientific Society, the Teknik, the Colorado Society of Engineers and the local associations of the four national engineering societies. The following officers were elected: Arthur Ridgway, president; E. G. Carpenter, vice-president, and Robert J. Grant, secretary and treasurer. Meetings of the council are to be held at least once a month.

Committee to Report on Site of Newark Bay Bridge

A joint committee of the county engineers of Essex and Hudson Counties and the bridge engineer of the New Jersey State Highway Commission has begun the study of the best site and design for a bridge crossing Newark Bay to connect Jersey City and Newark. The bridge would be about two miles long. An appropriation of $15,000 provided by the counties and the State Highway Commission is available for the study. F. A. Reimer of Essex, C. J. Wasser of Hudson, C. A. Mead of the State Highway Commission, and H. W. Hodge, consulting engineer, constitute the committee. Surveys are to be started at once, and meetings will be arranged to determine the wishes and needs of the public in respect to the location of the bridge.

John Fritz Medal Conferred on General Goethals

The formal ceremony of conferring the John Fritz Medal on Maj. Gen. George W. Goethals for his achievements in building the Panama Canal was observed in the auditorium of the Engineering Societies' Building, New York City, on the evening of May 22. Charles F. Rand presided, and addresses were made by William L. Saunders and the Hon. Henry L. Stimson. The latter was Secretary of War during the period when construction work on the canal was most active, and he described his observation at that time of the methods by which General Goethals maintained the *esprit de corps* and the discipline among the army of workers on the canal.

The formal presentation of the medal was made by Ambrose Swasey. In accepting the medal, General Goethals emphasized the credit due many others whose work contributed to the success of the enterprise, mentioning especially President Roosevelt as the one above all others who made the canal possible. Mr. Roosevelt's keen judgment in rejecting the majority report of the International Commission, which he had himself appointed, and adopting instead the minority report which favored the lock canal, saved the enterprise from disaster at a crucial time, he said.

Major General Goethals is the fifteenth engineer to receive the John Fritz Medal, and the third to receive it on account of work in the civil engineering field. The two other civil engineers who have been thus honored are J. Waldo Smith and the late Alfred Noble.

Cedar Lake Sealing Operations To Be Resumed

Sealing the Cedar Lake reservoir of the Seattle municipal water-works, officials of the water department announce, will be resumed as soon as the water goes down enough to leave a dry basin. The work done in 1918 had hardly progressed beyond the preliminary stages when the autumn rains made it necessary to close down work for the winter. The city retained J. D. Blackwell, consulting engineer, of Seattle, to make a further study of the plans for sealing the basin by sluicing methods, and his work has been carried on actively during the rainy season of the year.

Civil Service Examinations

New York.—Heating and ventilating engineer, office of state architect, $1500 to $2500 per year, June 28, apply to State Civil Service Commission at Albany for application forms before June 16.

United States

For United States civil service examinations, listed on the following page, apply to United States Civil Service Commission, Washington, D. C., or to any local office of the commission, for form 1312.

Chief of road survey party, $1800 to $2100 per year, transitman for road surveys, $1200 to $1800 per year, highway draftsman, $1200 to $1800 per year, Bureau of Public Roads and Rural Engineering, May 29. File applications before May 29.

Senior engineer and senior architect, Interstate Commerce Commission, $1800-$2700 per year, June 10. File application before June 10

Assistant designing engineer, Naval Ordnance Plant, South Charleston, W. Va., $9.20 per diem. July 8. File applications before July 8.

Valuation engineer, $3600-$4800 per year, and assistant valuation engineer, $2500-$3600 per year; technical staff, income-tax unit, Bureau of Internal Revenue, Treasury Department. No date specified.

Master computer, $2400 to $1800 per year, computer (Grade I) $1800 to $1400 and computer (Grade II) $1400 to $900, Ordnance Department. Applications will be received until further notice.

ENGINEERING SOCIETIES

Calendar

Annual Meetings

AMERICAN WATER-WORKS ASSOCIATION; 47 State St., Troy, N. Y.; June 9-13, Buffalo, N. Y.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS, 29 W. 39th St., New York; June 16-19, Detroit.

AMERICAN SOCIETY OF CIVIL ENGINEERS; 29 W. 39th St., New York; June 17-20, St. Paul-Minneapolis.

AMERICAN SOCIETY FOR TESTING MATERIALS; University of Pennsylvania, Philadelphia; June 24-27, Atlantic City, N. J.

AMERICAN CONCRETE INSTITUTE; 6 Beacon St., Boston; June 27-28, Atlantic City, N. J.

The American Society of Marine Draftsmen will hold its eighth annual meeting at the Hotel Brunswick, Boston, June 20-21. The officers of the society are: President, Alfred H. Haag, chief naval architect, United States Shipping Board; vice-president, W. A. Leavitt, Jr., New York Shipbuilding Corporation; secretary, B. G. Barnes, Lake Torpedo Boat Co.; treasurer, J. Binford Sadler, industrial department, United States Navy Yard, Norfolk.

The Montreal Branch of the Engineering Institute of Canada will tender a banquet to Brig. Gen. Charles Hamilton Mitchell, C.B., C.M.G., D.S.O., in the first part of June. General Mitchell is returning to Canada to reënter civil life after nearly five years in overseas service He has been decorated by the Governments of France, Belgium and Italy, as well as by Great Britain.

The Society of Terminal Engineers held its annual meeting in New York City May 20. Francis Lee Stuart, chairman of the engineering committee, United States Railroad Administration, previously chief engineer of the Erie and Baltimore & Ohio R.Rs., was elected president. Other officers elected for the coming year are: Vice-presidents, John Meigs, E. H. Lee, Calvin Tomkins, Charles Whiting Baker and Maurice W. Williams; treasurer, W. Joshua Barney; secretary, J. H. Leonard.

The Engineers' Club of Philadelphia elected the following officers at the annual meeting May 20: President, Joseph A. Steinmetz; vice-president, Paul Spencer; secretary and treasurer, Lewis H. Kenney. The club's last weekly luncheon of the season will take place June 3 and will be addressed by Dr. Samuel C. Sadler, on "American Potash and Its Sources."

The St. Louis Chapter of the American Association of Engineers has been elected a member of the Associated Engineering Societies of St. Louis, which body has unanimously approved the schedule of wages for city employees adopted by the St. Louis Chapter and its municipal section.

The New York Chapter of the American Association of Engineers has elected the following officers: President, Alexander Potter; vice-presidents, J. C. Patterson and Maurice Griest; treasurer, Hugh C. Jackson, and secretary, E. B. Miller, 294 Henry St., Brooklyn, N. Y.

The Chattanooga Chapter of the American Association of Engineers held a regular meeting May 21 at which the following temporary officers were elected: Chairman, J. L. Earles; vice chairman, R. E. Elgen: secretary-treasurer, Ray Dunlap.

The Pacific Coast Good Roads Association will hold its annual meeting in San Francisco June 25-26. The association is working in coöperation with the Pacific Coast Defense League, Inc., to provide a system of military highways on the Pacific Coast.

The Oregon Society of Engineers was addressed May 23 by Capt. J. W. Morris, Engineers, U. S. A., former city engineer of Portland, who spoke on his experiences as an Army engineer with combatant troops.

The Cincinnati Chapter of the American Association of Engineers was formally installed May 24 and was addressed by W. H. Finley, president of the national organization.

The Albany Society of Civil Engineers held a meeting May 27 at which S. T. Dodd spoke on the "Electrification of the Chicago, Milwaukee & St. Paul Ry.," the paper being illustrated by motion pictures.

The Rochester, N. Y., Engineering Society made a trip of inspection May 24 to the mines and plant of the Empire Gypsum Co., at Garbutt, N. Y.

PERSONAL NOTES

PROF. FRANK P. MCKIBBEN, head of the department of civil engineering at Lehigh University since 1907, has accepted an appointment, effective on Sept. 1, as professor of civil engineering at Union College, Schenectady, N. Y. Professor McKibben was graduated in 1894 from the Massachusetts Institute of Technology, and until 1907 served successively as instructor, assistant professor and associate professor in the department of civil engineering. During this time he was engaged also in work as assistant engineer for the Boston Elevated Railway Co., and the Massachusetts Railroad Commission. In 1907 he was appointed professor of civil engineering at Lehigh University, succeeding Dr. Mansfield Merriman. In 1918 he inaugurated a course in shipbuilding.

MAJ. EUGENE W. STERN, Engineers, U. S. A., who recently returned to this country and received his discharge from the service, has opened an office for the practice of engineering at 56 W. 45th St., New York City. Mr. Stern resigned as chief engineer of highways, Borough of Manhattan, New York City, to enter the Army.

MAJ. CLARENCE GOLDSMITH, Construction Division, U. S. A., who recently received his discharge from the service, has resumed his work as engineer for the Committee on Fire Prevention and Engineering Standards, National Board of Fire Underwriters, with office at 76 William St., New York City.

CAPT. PAUL HANSEN, Sanitary Corps, U. S. A., has returned to this country and has received his discharge from the service. He has resumed his position as chief sanitary engineer, Illinois State Department of Public Health, with headquarters at Springfield.

LIEUT. C. C. SADLER, U. S. A., who was assistant to the utilities officer at Camp Jackson, Michigan, has received his discharge from the service and has resumed his position as field engineer, coke plant, American Steel & Wire Co., Cleveland.

J. M. DUGAN and R. E. CHRISMAN, formerly with the Sound Construction & Engineering Co., Seattle, recently returned to Seattle from California and have become associated in partnership to engage in engineering and construction work, with offices at 312 Boston Block, Seattle.

R. J. WINDROW, of Waco, Texas, has been elected state highway engineer of Texas by the State Highway Commission, succeeding GEORGE A. BUREN, who has retired to private practice. Mr. Windrow is a graduate in civil engineering from the Agricultural College of

Texas, and has had extensive experience in roadbuilding in McLennan County, Texas. He recently resigned as city engineer of Waco to engage in contracting.

HENRY OAKES, Engineers, U. S. A., who recently received his discharge from the service, has been appointed city engineer of Muskegon Heights, Mich., in place of VICTOR BURTON of Lansing, to whom the office was offered but who was unable to accept the appointment, made several weeks ago.

CAPT. HENRY E. ROBERTSON, 344th Machine Gun Battalion, U. S. A., has received his discharge from the service and has resumed his work with the El Paso Bridge & Iron Co., El Paso, Texas.

MAJ. ROBERT I. RANDOLPH, 535th Engineers, U. S. A., has received his discharge from the service and has resumed his work as a member of the firm of Isham Randolph & Co., consulting engineers, Chicago.

L. A. WEATHERWAX, Hendrickson Construction Co., Seattle, and former secretary of the Seattle Master Builders' Association, has become associated with Stone & Webster on hydroelectric work at Fresno, Calif.

COL. H. M. WAITE, Engineers, U. S. A., has received his discharge from the service and has become associated with the Lord Construction Co., New York City, as vice-president and chief engineer.

C. A. DUNN, division engineer, State Highway Department of Oregon, with headquarters in Salem, has resigned to become general superintendent for Oscar Huber, contractor, Portland.

H. C. HEDDINGER, who for some time has been associated with the Aberthaw Construction Co., Boston, has been placed in charge of the new permanent office of that company in Buffalo, at 918 Ellicott Square.

DALTON MOOMAW, formerly road engineer of Cuyahoga County, Ohio, with headquarters in Cleveland, has been appointed county road engineer of St. Joseph County, Indiana, with office in South Bend.

HARRY BOLLINGER has been appointed city engineer of Columbia City, Ind., succeeding CLAUDE ANSPAUGH, who has resigned to devote his entire time to the duties of county surveyor.

LIEUT. CLARENCE A. LIVINGSTON, Signal Corps, U. S. A., has received his discharge from the service and has become associated with D. H. Burnham & Co., architects, Chicago.

GEORGE O. WITH, assistant manager, Consolidated Expanded Metal Co., Chicago, has been appointed city engineer of Joliet, Ill. He was previously assistant city engineer of Chicago Heights, Ill., for two years. During the war he served as chief carpenter's mate, Great Lakes Naval Training Station, in charge of sewer construction and water-supply. Previous to this service he was in the field service department of *Engineering News-Record*.

CAPT. E. P. RANKIN, JR., 110th Engineers, U. S. A., has received his discharge from the service and has returned to his work with the El Paso Bridge & Iron Co., El Paso, Tex.

PERRY FILKIN, division engineer, New York State Highway Department, has been transferred from Rochester to Hornell, succeeding S. E. FITCH, transferred to Utica.

ARTHUR A. SMALLEY, assistant city engineer of Pleasant Lake, Ind., has resigned to become assistant city engineer of Hamilton, Ohio.

ERNEST BRUCE, civil engineer, Charleston, W. Va., has been appointed chief of the engineering department of that city, succeeding HARRY WILEY, resigned.

E. R. KENNER has been placed in charge of the new permanent office of the Wellman-Seaver-Morgan Co. at Atlanta, which is located at 318 Hurt Building.

O. E. ECKERT, formerly with the engineering division, Michigan State Board of Health, has been appointed city engineer of Lansing, Mich.

WILLIAM S. MURRAY, consulting engineer, New Haven, Conn., has removed to 165 Broadway, New York City.

WALTER BOWMAN has been appointed city engineer of Harvard, Ill.

STEPHEN PALMER, of Clarksburg, W. Va., has been appointed county road engineer of Wetzel County, West Virginia.

BLAINE H. MILLER has resigned as building commissioner of Indianapolis, Ind., to devote his entire time to private business.

HARRY B. COOK, of Atlantic City, has been appointed a member of the State Board of Commerce and Navigation of New Jersey to fill the vacancy created by the resignation of Allen K. White.

OBITUARY

ALLEN E. NICHOLS, consulting engineer, Chicago, died in that city, May 8, at the age of 31. He was graduated from Purdue University in 1910, and for two years following was engaged in railroad work with the Baltimore & Ohio R.R. and the Chicago & Western Indiana R.R. He then became associated with Alvord & Burdick, consulting engineers, Chicago, engaged in sanitary engineering work. He served for two years as assistant engineer in charge of contracts and design of the municipal reduction plant and incinerator under Col. Henry A. Allen, for the Bureau of Waste Disposal. During the war he was employed by the du Pont Engineering Co. as assistant engineer of construction on the 70,000,000-gal. filtration plant for a powder plant at Old Hickory, Tenn. He had recently opened a consulting office in Chicago, in connection with his father, specializing in garbage and waste disposal.

CAPT. HENRY B. SAUERMAN, Engineers, U. S. A., who was one of the organizers of the first company of Army engineers in the State of Illinois, died in Chicago, May 20, at the age of 40. He was a member of the firm of Sauerman Bros., engineers and manufacturers of construction equipment, Chicago. He entered business in the employ of Fairbanks-Morse & Co., where he remained for 11 years, first as chief draftsman and later as contracting engineer. In 1911 Mr. Sauerman joined his brother, John A. Sauerman, in organizing the firm of Sauerman Bros., succeeding the H. N. Elmer Co. When the original Co. A, Engineers, Illinois National Guard, was formed in 1911, Captain Sauerman enlisted for three years as a private, but was elected captain a year later. In 1918 he received the Octave Chanute medal from the Western Society of Engineers for his paper "Fortification," which was prepared for a meeting of the society in 1916 and was later published as a handbook for Army engineers. Later his booklet, "Highways and Railways for the Defense of Our Nation," attracted considerable attention.

WILLIAM TRUTCH PRESTON, principal assistant engineer, United States Engineer District, Seattle, died in that city May 14. He was born in 1859 and went to the Canadian Northwest as a civil engineer in 1880. He had charge of construction work on the Canadian Pacific Ry., including that in Frazier River cañon. Later, for two years, Mr. Preston was engaged in construction work for the Seattle, Lake Shore & Eastern R.R. Since 1896 he had been continuously in the service of the United States Government. He was connected with fortification work in the Boston district for five years, and with river and harbor fortification work in the Seattle district during the remainder of his service. The major portion of the fortification works of the coast defenses of Puget Sound was constructed under Mr. Preston's supervision. He was also connected with the construction of the Lake Washington ship canal. During 1918 he was in charge of the Seattle district as district engineer.

LOUIS ARTHUR KINNEAR, of the engineering staff of the Ontario Hydro-electric Commission, died at Nipigon, Ont., May 12. He was graduated from Queen's University, Kingston, in 1912, and acted as engineer for several municipalities.

New Semi-Trailer Has Collapsible Auxiliary Wheels

A new tractor and semi-trailer designed to facilitate coupling and uncoupling, and to allow for turning in the shortest possible radius, is shown in the accompanying illustration. This trailer, having four wheels when uncoupled, may be shifted around for loading without the use of the tractor. The outfit shown is the regular four-ton unit, being manufactured by the Fulton Motor-Truck Co., of Farmingdale, N. Y.

TRACTOR AND SEMI-TRAILER MAKING A SHORT TURN

The main features of this transportation unit are the method of coupling and the collapsible wheels on the front of the trailer which rest on the ground while it is being loaded, and allow for shifting.

To facilitate coupling, the tractor has two flared runways at the rear, one on each side, which pass under two small wheels on the bottom of the trailer body. As the tractor backs up to the trailer, these small wheels run up the inclined runways, lifting the front of the trailer from the ground. As the wheels pass up the runways, they are controlled by guides on each side, which bring the coupling device into position. The coupling is completed automatically. By means of a hand lever, the front supporting wheels of the trailer may now be lifted and clamped free of the ground, as shown in the view.

The two small forward wheels which guide the coupling device up the runways rest and roll upon a circular wheel similar to a turntable, thus steadying the trailer. When it is desired to uncouple the trailer, the operation is controlled entirely from the driver's seat. By pulling a lever he releases the front supporting wheels of the trailer, which are thrown into a vertical position. At the same time the brakes on the rear wheels of the trailer are set, and the tractor can be freed and attached to another trailer.

National Association of Manufacturers Elects Officers

At a meeting of the board of directors of the National Association of Manufacturers, held in the Waldorf-Astoria Hotel, New York City, following the 24th annual convention of the association, the following officers were elected: President, Stephen C. Mason; treasurer, Henry Abbott; general manager and assistant treasurer, J. Philip Bird; secretary, George S. Boudinot.

Very Little War Motor Equipment to Be Sold

A comparatively small amount of used passenger and commercial cars, not adapted to Governmental use, will be sold at public auctions to be held at various military posts and camps beginning June 1, according to C. W. Hare, director of sales. The major portion of all present surplus motor equipment is now being transferred to Governmental departments. Over 10,000 motor trucks, passenger cars, ambulances and motorcycles have already been transferred, deliveries having been made to the Postoffice Department, the Public Health Service and the Department of Agriculture, the latter having received about 5000 trucks to date. As fast as the several states place in operation the consignments made through the Department of Agriculture, the director of sales will transfer additional trucks and roadbuilding machinery. The needs of the departments mentioned are expected to absorb practically the entire surplus of motor vehicles acquired for military purposes.

BUSINESS NOTES

THE ALLIED MACHINERY CO. OF AMERICA announces that it has increased its capital stock to $5,000,000. This was made necessary by the decision of the American International Corporation to group all of its machinery export selling subsidiaries under one head, completely absorbing the Allied Construction Machinery Corporation. The Allied Machinery Co. de France, the Allied Machinery Co. d'Italia and the Horne Co., Ltd., of Japan, while retaining their corporate entities, will also be directly connected with the Allied Machinery Co. of America, rather than the American International Corporation, as before. The Allied Machinery Co. of America is at present operating in 14 countries. J. W. Hook will continue as president. F. A. Monroe, in charge of administrative affairs, S. T. Henry, in charge of sales and advertising, and T. G. Nee, devoting his attention to the affairs of the Horne Co., Ltd., have been elected vice-presidents. R. P. Redier is general sales manager of the company, with headquarters in Paris.

THE STANDARD ELECTRIC AND ELEVATOR CO., of Baltimore, has opened a New York office at 280 Broadway, in charge of C. A. Yarrington, formerly sales manager of the company. M. H. Jones, with the Westinghouse Electric Mfg. Co. for 15 years, has resigned to succeed Mr. Yarrington as sales manager of the Standard company.

THE MASSEY CONCRETE PRODUCTS CORPORATION announces the opening on June 1, of a Pittsburgh office at 1405 Oliver Bldg., with A. F. Humphrey as resident manager. It also announces the appointment of J. A. Higgs, Jr., as resident manager of the Southeastern district, with headquarters in the Candler Annex, Atlanta, Ga.

THE CENTRAL FOUNDRY CO., New York City, announces that George A. Harder has been elected president and director of the corporation and its subsidiaries. Mr. Harder is also president of the Essex Foundry Co., Newark, N. J.

TRADE PUBLICATIONS

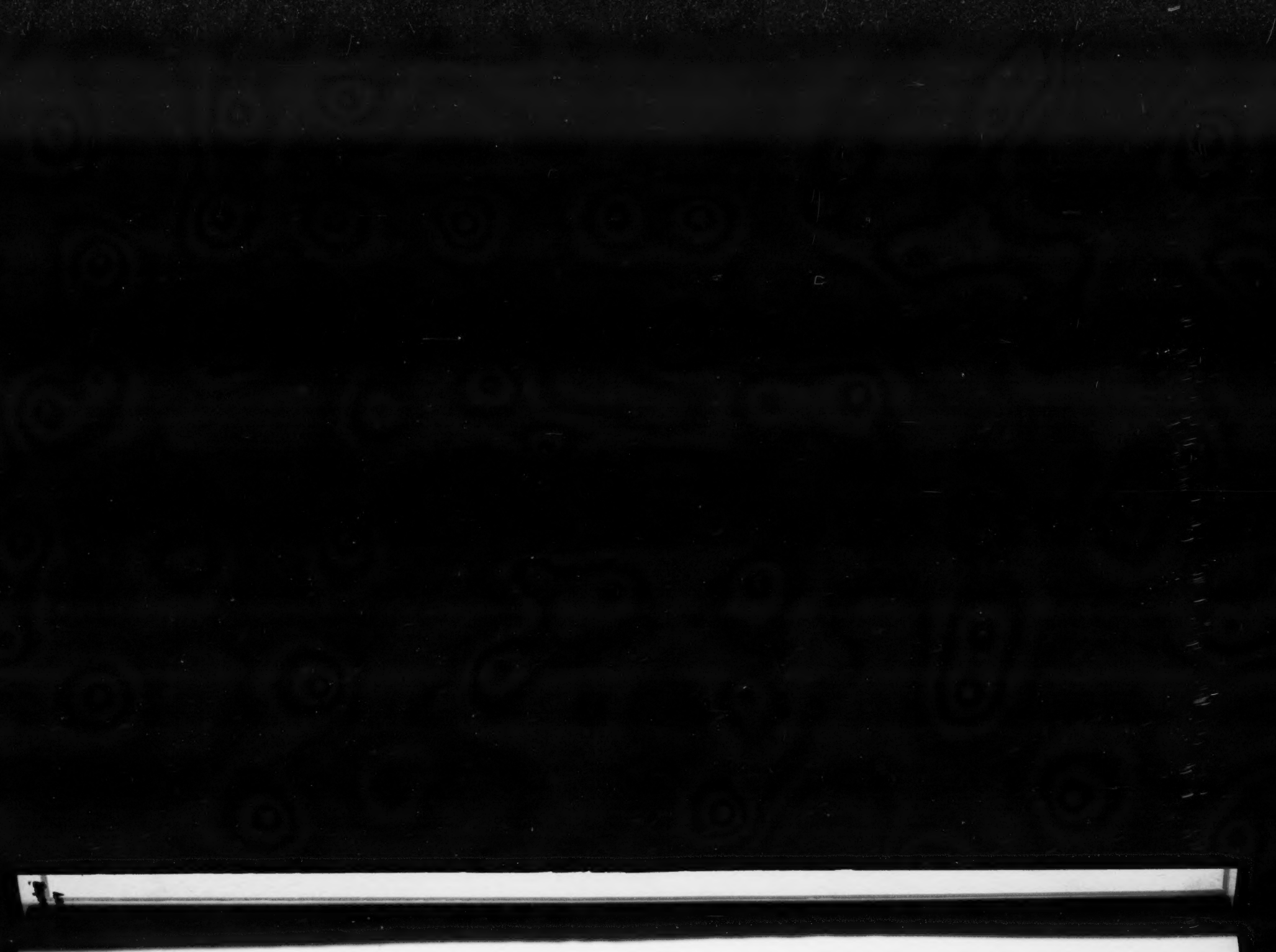
The following companies have issued trade publications:

THE JAEGER MACHINE CO, Columbus, Ohio; two catalogs, 7¾ x 10¾ in., 32 pages, and 6¾ x 10 in., 16 pages, illustrated; describe concrete mixers and the layout for their use.

THE LOCOMOTIVE SUPERHEATER CO., 30 Church St., New York City; Bulletin T-2, 8 x 10½ in., 8 pages, illustrated; describes the use of "Elesco" superheater to secure the advantages of the use of superheated steam in stationary boilers.

THE BUFFALO FORGE CO., Buffalo, N. Y.; section 400 of the catalog, 5 x 7½ in., pp. 403-436, illustrated; pertains to fans, blowers and exhausters.

THE WHITING FOUNDRY CO, Harvey, Ill.; folder, 8½ x 11 in., 4 pages, illustrated; gives names of users and describes Whiting bucket cranes.

WILLIAM H. WOOD, hydraulic engineer, Media, Delaware County, Penn.; catalog, 63 pages, illustrated; embraces all kinds of hydraulic machinery and improved locomotive boilers.

THE T. L. SMITH CO., Milwaukee, Wis.; two pamphlets, 7½ x 10¾ in., 16 pages each, illustrated; concrete mixers for paving work and pumps for construction and industrial work are the respective subjects.